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A NEW YEAR; A NEW OFFICIAL FAMILY; THE OLD IDEALS

In this changing world of both physical and biological forms stand the IDEALS by which men guide their intellectual life and the organizations they found. For the Central Association of Science and Mathematics Teachers conventions come and go, new officers annually gratefully accept the honor which the trust and confidence of a great group of teachers weaves into their life by an election to office. The hour of thrill moves into the hours of service, and sooner than we think, with a tinge of sadness we step into the never changing rank of "retired officers." The official family and their activity is the perpetually changing phase—call it the electronic phase—if you please, of the Central Association of Science and Mathematics Teachers. It is held in place by the nucleus of our fine organization, the ideals of a teacher group. Like the nucleus in the physical world determines the weight of an element so, too, do our ideals determine the weight and significance of an organization. For nearly half a century CASMT has been a living monument to high ideals in the teaching profession.

It is an ideal supreme which sets BETTER TEACHING as an ever expanding goal. It recognizes that to us are entrusted the many "worlds" of the lives of our students where mistakes cannot very easily be erased, perhaps not at all. As teachers we are, however, privileged to live on in the lives of ours students, ours is a wonderful opportunity and a great obligation. These must have been the thoughts of the founders of CASMT. Their ideals have endured, to them we pledge our service in 1948.

J. E. POTZGER, *President*
Butler University, Indianapolis

1948 ANNUAL CONVENTION

INDIANAPOLIS, INDIANA NOVEMBER 26 AND 27

THINKING VERSUS DOING IN GENERAL SCIENCE

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At the beginning of this activity you will find a number of *Introductory Questions*. These are to be answered *before* the demonstration is performed, and are placed there to enable the pupils to get some idea of how much they already know about the topic of the activity. Their knowledge may come from previous reading; it may come from experience, or perhaps from something they have seen, heard, or done. They should, when answering these questions, do more than simply answer the question as it is stated. Go a little further and try to point out some important fact which is involved in the question.

When the activity is performed, be sure that they understand what each part of the equipment is—both what it is *called*, and what it *does*. As each step in the activity is performed, be sure that they know what is happening. Pupils should not hesitate to ask a question if they honestly cannot reason out the answer for themselves. When the activity is completed, they should think it over and write down in a simple sentence what important fact was pointed out by the activity.

Following the activity is a list of *Interpretation Questions*. In answering them, the pupils should show the connection between the answer to the question and what the activity pointed out. If they are in doubt about the meaning of a question or its answer, they should consult the Glossary (science words) or Index of any scientific book or other references. In using references, they should look up *all* the important words in the question. Using references will save the pupils much time and effort.

UNIT: COMPLEX MACHINES

Topic Study: The Locomotive[1] versus the Ocean Liner

Introduction

1. In the days before coast-to-coast trains were used, how were supplies from the Atlantic Coast sent to miners in California?
2. Give a report on the first movable steam engine made in America. By whom, and when, was the first locomotive invented?
3. Write a report on James Watt. How did he improve the steam engine?
4. Why do railroads take a winding route through the mountains?
5. How has railway transportation been improved recently? Ap-

[1] For an extended and an interesting treatment on the locomotive, excellent in diagrams, see:
Bock, George E. *What Makes the Wheels Go Around?* New York: The Macmillan Co., 1931, pp. 34–42, 47–54.

ACTIVITY: OPERATION OF STEAM ENGINE.[2]

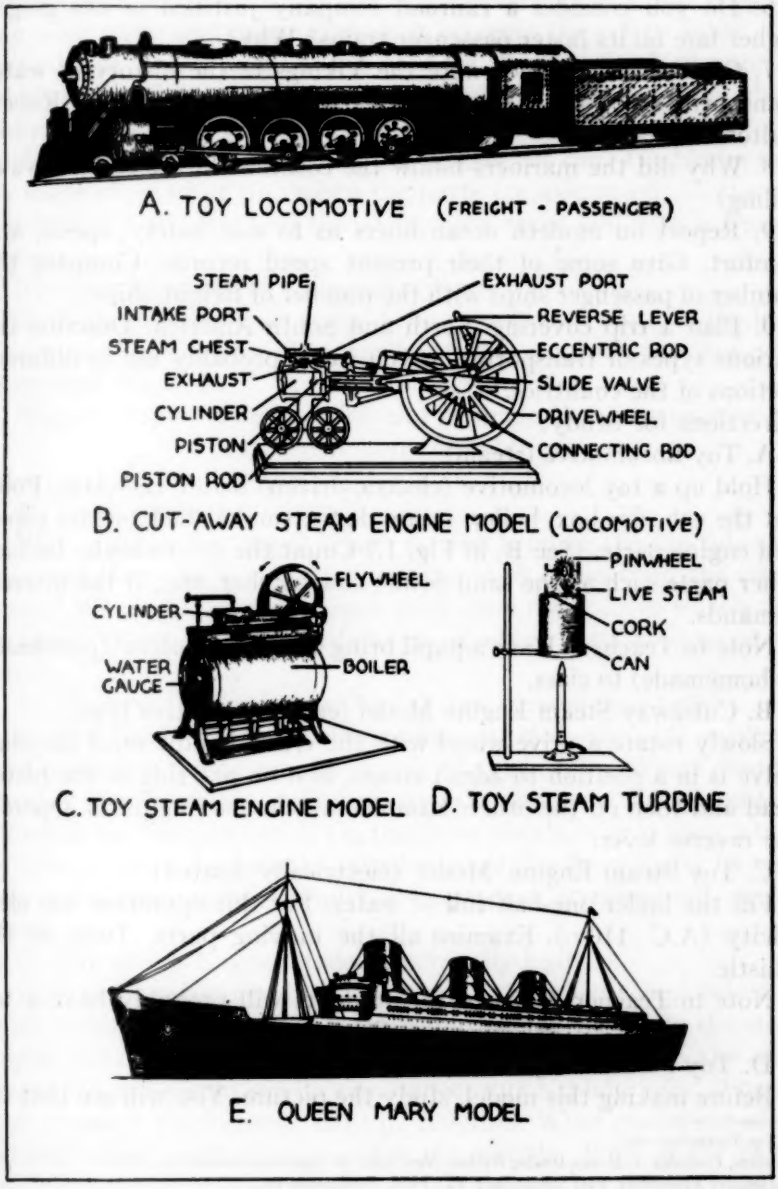

FIG. 1.—Power from Steam.

[2] This demonstration may consume several classroom periods. The intensity of the work depends largely on the type of class. Boys with mechanical ability will be more interested in the practical application of machines.

proximately how many passengers can be seated in a modern railroad coach?

6. Do you consider a railroad company justified in charging a higher fare on its faster passenger trains? Why?

7. Of what importance were the Vikings in the history of water transportation? What contributions did John Fitch and Robert Fulton make?

8. Why did the mariners follow the coastline in the early days of sailing?

9. Report on modern ocean liners as to size, safety, speed, and comfort. Give some of their present speed records. Compare the number of passenger ships with the number of freight ships.

10. Plan a trip covering North and South America. Describe the various types of transportation you would probably use in different sections of the countries.

Directions for Study:

A. Toy Locomotive (steam)

Hold up a toy locomotive (electric-driven) before the class. Point out the cab, fire box, boiler, steam dome, smoke stack, steam pipes, and engine parts. (See B. in Fig. 1.) Count the drivewheels. Include other parts such as the sand dome, cow catcher, etc., if the interest demands.

Note to Teacher: Have a pupil bring a toy locomotive[3] (purchased or homemade) to class.

B. Cut-away Steam Engine Model (early locomotive type).

Slowly rotate a drive-wheel with the crank handle until the slide valve is in a position to admit steam, first on one side of the piston head and then on the other. Examine all the moving parts. Operate the reverse lever.

C. Toy Steam Engine Model (electrically heated).

Fill the boiler one-half full of water. For this operation use electricity (A.C. 110v.). Examine all the moving parts. Turn on the whistle.

Note to Teacher: Some of the students will probably have a toy steam engine (burner type).

D. Toy Steam Turbine (homemade)

Before making this model, study the picture. You will see that the

[3] For dimensions, see:
Collins, Frederick A. *Money-Making Hobbies*. New York: D. Appleton-Century Co., 1938.
Miniature Railroading. East Stroudsburg, Pa.: Penn. Publication, Inc.
Model Building. Mt. Morris, Ill.: The Lionel Corp. (locomotives) excellent illustrations.
Railway Age. Philadelphia: Summons-Boardman Publishing Corp. (excellent illustrations).
The Mantua "HO" Handbook. Woodbury Heights, N. J.: Mantua Metal Products Co., 1941.
The Model Craftsman. East Stroudsburg, Pa.: Model Craftsman Publishing Corp. (airplanes, locomotives, ships).
The Model Railroader. Milwaukee, Wis.: Tamback Publishing Co. (excellent illustrations).
The Railroad. Chicago: The Atchison, Topeka, and Sante Fe Railway Co.

boiler of the turbine is a can which once contained evaporated milk. Two holes, a larger one near the edge and a smaller one near the center, have been punched in the top. The larger one is for filling the can with water and, when corked, it becomes the safety valve. The second hole is very small and is used for the escaping of the steam, which strikes, in turn, the blades of the wheel. The axle of this wheel, either a wire or a sewing needle, is supported by an upright tin, soldered to each of the two opposite sides of the can. The blades may be made of wood or tin. When the parts are assembled, fill the can one-half full of water and then bring to a rapid boil with a Bunsen burner.

E. Ocean Liner Model (Queen Mary).

Hold up an ocean liner model before the class. Point out the location of the engine, propellers, smoke stacks, etc. Include other parts if interest demands.

Note to Pupil: These models can be made from kits obtained at department stores or hobby shops.

Observations from Study:

A. Toy Locomotive (steam).

Why is the boiler large? Where do you suppose the fire tubes are located? How can you distinguish the sand dome from the steam dome? Where do the steam pipes lead? How many drive wheels does it have? Why? Include the function of other parts as interest demands.

B. Cut-away steam Engine Model (early locomotive type).

As you slowly rotate the drive wheel, what do the slide valve rod and the piston rod do simultaneously? Explain fully. Where does the dead steam leave the cylinder? Explain the term "dead center." When is the cycle repeated? On the drive wheels, why is there a mass of iron opposite the point of attachment of the drive shaft? Of what use is the steam chest, cylinder, exhaust port, eccentric rod, reverse lever, etc.?

C. Toy Steam Engine Model (electrically heated).

How is the steam generated? Why isn't the boiler completely filled with water? Of what value is the water gauge? Where do the steam pipes leave and enter? As the fly-wheel rotates, what do the slide-valve rod and piston rod do simultaneously? Explain fully. Where is the eccentric rod located? Give its function. What comes out of the whistle vent? Give the cause for the whistle. Why is the engine equipped with a safety valve?

D. Toy Steam Turbine (homemade).

What comes out of the vent? What does the water do when it changes to steam? What do the blades do? Why must the blades be light in weight?

E. Ocean Liner Model (Queen Mary).

Where are the engines located? Why? How many propellers does the ship have? Suggest a reason for this? How many smoke stacks do you observe? It has been said that some ocean liners have dummy stacks. Explain.

Interpretations

1. Why are steam trains more likely to be late in winter than in summer?
2. Give as many reasons as you can for the low efficiency of the steam locomotive.
3. What causes a tea kettle to make a singing noise? What causes the puffing sound of a locomotive? Explain why the puffing of a locomotive increases as the train speeds up.
4. Why do locomotives sometimes leave a trail of "white smoke" behind them?
5. Which is cheaper: traveling by boat or by train? Give reasons for your answer. Discuss freight transportation.
6. How can you tell whether a ship is heavily or lightly loaded?
7. Explain the use of steam as a means of motive power for ships. In the early days what was used instead of steam?
8. Why are side-wheel boats unsatisfactory for use on the ocean?
9. Give an example of a modern steamship equipped with steam turbines. What are the advantages of using steam turbines in ocean liners? Explain. Why are the blades of the steam turbine made different lengths?
10. Why are many large cities located on large bodies of water? What equipment is necessary to continually improve the harbors?

ERRATA

On page 54 of our January issue the equation

$$\frac{fay}{f(bc+dx)} = \frac{a(ex+fy)}{a(gh+lx)-f(bc+dx)}$$

should have read

$$\frac{fay}{f(bc+dx)} = \frac{aex}{a(gh+lx)-f(bc+dx)}$$

On page 81 the book listed as Experimental Physics should have been Experiential Physics.

THE EFFECTIVE ADMINISTRATION OF HIGH SCHOOL BIOLOGY TEACHING UNDER STATE SUPERVISION

PART II. COMMENTARIES ON STATE EXAMINATION QUESTIONS USED IN 1947

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One of the most difficult tasks always confronting the teacher is the devising of a satisfactory test. Volumes of excellent advice have been written, will continue to be written as long as examinations of any kind are given. Progress would be hindered if improvements were not made. Techniques change, and we would not have it otherwise as long as what is worth while is retained for use until found to be inadequate. The purpose of criticism is to foster the adoption of more careful procedures and better methods. It is not to destroy wantonly.

The individual gains, to summarize briefly, in his testing technique by constantly scanning his effort, by studying every detail of all the ways and means at his disposal, by critical evaluation of results in terms of objectives sought, and by keeping everlastingly at it by doing with an eye to betterment. A minimum foremost essential, of course, is an accurate knowledge of subject matter, or at least access to the same. There are a number of methods of written questioning which have proved their worth over many years of trial for particular situations. These may be elaborated upon and varied almost endlessly depending upon the ingenuity of the teacher.

The older basic patterns *can* be modified and adapted because the author does so in his classes from period to period and year to year. The advantage of this is that it keeps the student mentally awake. What is novel, in itself, creates a test, brings out hidden resources needed to meet the situation. Newer routines are of value and will appear as long as the spark of inventive genius remains alive.

But objectives should always be clear as they vary from time to time. One may seek merely to find out the extent of fact retention. Or he may wish to discover evidence of original and individual thinking; and again it may be a pure exercise in presenting some critical conditions to be faced squarely and solved without confusion.

This, however, is not the place for extended dissertation upon examination problems. It is enough to show that the author has full appreciation of the magnitude of the task and an inkling of the pitfalls open to catch the unwary preparer. The formulation of standard tests for application throughout a wide area is a hazardous matter, one requiring superb technical skill, peculiar talents, and an under-

standing of the burden of responsibility which the circumstances demand. The records of many individuals hinge upon the care with which a test is assembled. A fair, "fool-proof," well-rounded, comprehensive, truly finished instrument within the scope of the powers and training of the group participating should be attempted with humility. Nor is criticism of the conscientious performance to be entered into lightly. Sympathy and understanding should pervade the thinking of the critic here, as he tries to assay the value of the sample at hand.

A previous paper, part one, entitled "Critical Review of a Scope-Content Outline for Teacher Guidance," has dealt with the problem of sufficiency of a four-page digest prepared by a special biology committee so that the secondary school instructor might secure better results in the examinations given. The present critique concerns the set of examinations issued following the presumed use of the instructional guide. It may or may not be that the same group of classroom teachers prepared both documents. It seems likely that they did, or at least had knowledge of the scope-content outline from state headquarters which was to supplement, and to some extent replace, the regular syllabus now in process of revision.

Lengthy criticism of the syllabus is of doubtful value in this instance because it is being revised. However, it had to be relied upon by the teacher to considerable degree and the point was emphasized by the authorities that its use should not be abandoned. Therefore it does enter into the entire picture in part and will be mentioned as having much bearing on the current study. In comment hereafter where "outline" is used or "syllabus" mentioned the official directives are meant.

Directions provided the pupil as to manner of proceeding are important. In any state there must be a certain percentage of shift in population from year to year. This cannot help but mean that new pupils enter who are unfamiliar with effective regulations. For their sake, especially, there should be no reasonable chance for error. The two paragraphs in fine print on the examination paper in question, relating to numbers of recitations and laboratory periods, length of same, and state requirements, constitute administrative detail for which the pupil should not be responsible. It should be the office of the teacher and principal to certify whether compliance with law is had. Below the fine print is a space labeled "Name of pupil," a second, "Name of School." These identify the paper and are enough.

Directions which precede them are confusing. One sentence reads "A paper lacking the statement of laboratory work will not be accepted at a standing less than 75 credits." After much thought and investigation it is believed that this means "The passing mark for any

paper lacking the statement of laboratory work will be 75." In other words, the pupil is penalized for not doing what is very obviously the job of the teacher or principal, and the meaning is obscure to say the least. It *appears* to mean, at first glance, that a paper which does not report the amount of laboratory work taken will be graded *at least* 75.

The local teacher grades the performance. He submits the marks to the principal (if the routine in this case is understood), who in turn sends papers and records to headquarters where results may, or may not, be checked. Careful identification with name of pupil and name of school is, therefore, sufficient. In fine print the pupil is told to write at the top of the first page of his answer paper (a) the name of the school where he has studied. Nothing is said about *his* name. Later he is directed, in italics, to write answers on the "question paper" and hand the same in "with the other answer paper." It is to be hoped that the teacher understands the system and has made it clear to all before anyone begins. How much simpler to have said "Write your name and that of your school on each paper which you hand in," then to explain the other points as might be needed.

Equally disconcerting is the advice immediately preceding the completion statements of Part I, of which there are *nineteen*. (There could just as easily have been twenty, not only for the sake of uniformity and scientific orderliness but for giving an easy checking arrangement, with *ten* modified true-false, followed by *twenty* multiple choice instead of the twenty-one.) We find "Write on the line at the right of *each* statement the term which, when inserted in the blank, will make the statement true."

At first thought correction of a true-false statement seems intended. Re-reading and scanning of several samples reveals that the *addition* of a *correct* term to *complete* the sentence is wanted. Truly, making perfectly clear tests is not a simple matter. Very careful editing by a group of critics is needed. "Write a term in each blank space provided so as to make the following ideas complete and correct" registers two thoughts, in the author's mind, both important, in their logical sequence. The implication of having to rectify a misstatement is thus avoided.

In spite of being told to place terms at the *right* the student finds that two of the blanks to be filled occur in the *middle* of their respective lines, not as specified. Hairsplitting? Presumably, yes. When, however, is the ideal of strict scientific accuracy to be attained? Is it to be praised but not practiced?

Twice within five spaces or lines of print, also, the pupil is told to "Answer all questions in part I." The double precaution may be necessary. But it is not adopted for all the commands issued. The

pupil has had a year of exposure to methods of observation and exact training. Is it too much to expect that by now he is habituated to careful scrutiny of what is of moment to him?

The nineteen completion questions, commented upon, are as follows:

1. "Raw materials needed by a green plant for the manufacture of carbohydrates are carbon dioxide and . . . "

"Water" would seem the simplest answer in the world, perfectly obvious. How could anyone, who had attended class regularly, miss? Certainly photosynthesis, one of the outstanding processes in nature, (some claim *the* one), must have been discussed. The topic was in the outline. The syllabus says " . . . green plants . . . take in water and carbon dioxide—and, with the help of light energy . . . construct . . . carbohydrates." The teacher has full leads here. Yet, of ten, thoroughly acceptable, dependable high school biologies not one puts the whole thought in so many words. Every account is good. Some are extraordinarily so, splendidly illustrated and diagrammed.

The syllabus, however, in another unit makes the erroneous explanation, through typographical error or oversight, that " . . . all plants take in soluble inorganic (food) and build (them) up into organic form."* Title page of the booklet indicates that 1936 was the date when the present "content" was completed. "Foreword" explains it " . . . is the result of approximately a year and a half of conscientious work on the part of the committee selected for this purpose." Five members comprised the personnel, one head of a science department, one teacher of general science and biology, one instructor in science education, one head of department of biology and general science, and the state supervisor of science. One was a college instructor, three were in secondary school work, one an administrator. Apparently only one of these was a classroom biology teacher.

Examine the quoted syllabus declaration taken from the section on " . . . unity among all living things" and note the categorical "all plants." Presumably the absorption of "soluble *inorganic food*" which is built up into *organic* form is a criterion of "unity among *all living things*." The parasitic and saprophytic fungi are plants. But they do not carry on nutrition in the same way that the chlorophyl-bearing algae and mosses, ferns, spermatophytes do. Far from it. Moreover the inorganic components of soil and air, the water and carbon dioxide of the first test sentence, are "raw materials" and *not* food. The plant does not derive from them its energy nor its growth

* Parentheses inserted for singular and plural comparison.

and repair-producing qualities. These come from the carbohydrates, proteins, and fats which are manufactured by using the simpler *inorganic* matter. Food is *organic*. Very rarely is energy for living activities obtained from any other source. This is a basic, biochemical concept. The informed biology teacher tries to make it clear to his pupils.

If, however, authorities err in an official presentation to supervisors principals, and teachers, what is the percentage of error likely to be among the ignorant beginners? The writer has found, in spite of comparisons with factories, everyday similes, diagrams of several types, repeatedly and exhaustively explained, that both secondary school and college biology students find photosynthesis very puzzling. Many have no background in chemistry at all other than what can be introduced in the biology course itself, which must be utterly inadequate for dealing with the *synthesis* of *organic compounds*.

They confuse raw materials with chlorophyll, the agent, wholly misinterpreting its catalytic behavior because they have no basis for understanding it. "If it is a chemical compound itself why shouldn't it take part in the reaction directly? What *is* a *reaction* anyway?" Oxygen is misplaced as a by-product. If this element has any meaning to them at all it signifies activity and a vital role. They have a vague notion of its use in respiration and energy release through oxidation. "How does it happen to be a *left-over* in this case?" They often do not realize in the slightest the difference between matter, as substance, and energy as what cannot be weighed or felt. "Just *how* does chlorophyll within the chloroplast *use* light?" Thorough drill of the simplest kind is required that relationships of this very complex process may be kept straight.

For eleven years secondary school biology teachers were confronted with the syllabus' misinformation on the point. Yet a test on photosynthesis is entirely proper. Few comprehensives would be without some reference to it. About half the texts will use the definite words "raw materials," others will say simply "carbon dioxide and water" or "inorganic compounds," etc. Could not the sentence have read "Raw materials needed by chlorophyll of the green plant for the manufacture of carbohydrates (sugars) are carbon dioxide and . . . "? Why make it too easy, you say? In numerous places throughout the examination helps are given. Number eight, farther on, uses "ductless glands," in parenthesis, to explain "endocrine glands." The formulators of the paper have established the precedent. The inclusion of chlorophyll also automatically rules out confusion of "green plants" with non-chlorophyll-possessing "green" molds, which are, after all, plants with a decided color, which is *green*.

2. "The function of the contractile vacuole found in the protozoa is . . . "

This invites immediate disaster. Calkins and Summers, in 1941, edited and produced a comprehensive review of protozoan problems, covering 1113 pages, entitled "Protozoa in Biological Research." The articles therein were written by the foremost authorities and research workers in their particular fields. Chapter seven, by Dr. J. H. Weatherby, on "The Contractile Vacuole," relates that "In spite of the quite extensive literature dealing with the question, one is obliged to admit that virtually nothing has been proved beyond question concerning the function or functions of contractile vacuoles . . . the contractile vacuole certainly has not been proved an organelle whose main function is excretion of metabolic wastes."

What the contractile vacuole in the protozoa does has been under investigation for a long time. The matter was debated at Yale in 1921, for example. Dr. Buchanan presented the problem for discussion in general physiology class by pointing out that freshwater protists contain the organelle, many marine forms do not. If it is eliminative for nitrogen wastes, etc., how do those forms having no contractile structures dispose of theirs? Storer is typical of the college general biologist's and zoologist's views when he writes that the primary work of the little mechanism is *apparently* to regulate water content, that it serves only in part for excretion.

The outline has prepared for an examination contingency of the protozoan kind by recommending familiarity with the "general structure and functions of one or more protozoa." *How many more* we are not told. The teacher must use his discretion,—or intuition.

The syllabus *approaches* the situation *functionally* with such general statements as "The single animal cell . . . must eliminate its waste products." What has not been done by the producers, it seems, is to have become accurately acquainted with the appropriate *advanced* courses in biology where such a mistake would soon be made evident. Of all the possible facts in the protozoan world, a living microcosmos all by itself, available for questioning it is both surprising and ironical that blind chance should have selected a particular one not yet satisfactorily demonstrated, for which there are at least two answers acknowledged to be tentative by protozoological authorities, with the one most likely to be given, excretion, that is, (as later study showed) the least acceptable!

How would the informed secondary school biology teacher, (there must be more than a *few*), grade whatever answers appeared? Of course, if alert, he would have provided his class with the proper knowledge in spite of what some allegedly reliable sources might have said. He could even disregard the question in the exam and trust to chance that no one above him would pick up the omission. But if his personal interpretation were noted, and the headquarters

marker disagreed with his opinion, what a spot he would be in! How often would such a contingency arise in a poorly constructed test to vitiate the results and damage the record of well-prepared pupils? It is a matter not to be dismissed with a mere shrug of the shoulders.

3. "Cretinism is an abnormal condition caused by a lack of the hormone . . . "

Note "abnormal condition" and compare with #18.

4. "One way in which protozoa reproduce asexually is by the process of . . . ',

Budding, though rare in this phylum, *is* present. ***Fission*** is probably meant. If "budding," common elsewhere, had been given would it have been considered correct? Neither outline nor syllabus is very helpful on this score.

5. "The living substance that surrounds the nucleus of plant and animal cells is . . . "

Here is an ambiguity permitting two equally correct answers, "protoplasm" or "cytoplasm." (In one test, inspected later, a girl with a *good mind* did give "protoplasm" which was called the "wrong" term.) All living matter is protoplasm, whether that of the nucleus or what surrounds it. "Nucleoplasm" and "cytoplasm" are convenient cytological designations when it is desired to tell one from another and they do show marked physical and chemical differences. "That portion of protoplasm outside the nucleus is called . . . " expresses the thought so as to avoid all confusion.

The outline *omits specific* discussion of living substance, the basic life-stuff of all organisms. The syllabus misleads by saying "Nucleus and cytoplasm together constitute protoplasm." There is no *together* about it. *Either* is protoplasm *without* the other. *Both interacting* together constitute a unit mass of live matter called variously the cell, a whole organism sometimes, or a syncytial or coenocytic mass that is multinucleated. Any part of living matter is protoplasm. This is a vastly different concept from the requirement that nucleoplasm and cytoplasm must be in combination in order to form protoplasm. In the very modest protists of the "lower" levels it is very difficult, if not impossible, to say what is cytosomic, cytoplasmic, or nuclear. They are protoplasm, however.

6. "The transfer of pollen from the anther to the stigma is called . . . "

Some botanical authorites (Youngken's "Pharmaceutical Botany," p. 290) consider this a partial truth and include the consequent germination as complementary to pollination. The outline and syllabus are both deficient in their treatment, hybridization and inbreeding being the closest references.

7. "Digestion in the human body begins in the mouth . . . "

Fortunately *both* phases of digestion, chemical and physical, begin in the mouth. The outline makes no differentiation. The syllabus calls digestion "a catalytic process," which the chemical part (hydrolysis) is. A very large percent of digestive activity is also purely physical (mechanical), such as osmotic action in absorption.

8. "Secretions of endocrine glands (ductless glands) pass directly from the gland into the . . . "

Use of both characterizations is considered warranted by the compilers, the outline adopting "ductless," the syllabus recommending that "types of endocrine organs" be shown. Either is correct but to keep teacher-aids consistent a single term might better have been used. Neither guidance directive lays emphasis on the critical point, namely, passage of secretion directly into the blood stream without usage of ducts.

9. "An organism that commonly reproduces by budding is . . . "

With such quantities of biological facts available why is it necessary to have two so nearly alike? Cf. #4. A great many examples of the phenomenon could be given involving animals or plants. The outline emphasizes asexual reproduction which may account for its inclusion several times in the examination.

10. "A doctor usually administers injections of . . . to a person ill with diphtheria." (Note position of blank for answer.)

The outline includes antitoxins but no specific diseases. In a unit on health promotion only one sentence in three pages devoted to the topic reads "Vitamins serve to prevent various deficiency diseases and in general to keep the body in good tone." Considering the importance of infection and contagion this is scanty treatment of *diseases*.

11. "The biologist who originated the theory of 'survival of the fittest' was . . . "

Uncritical use of "originated" here is, indeed, a sorry commentary upon familiarity with the historical background of biology. McDougall and Hegner's fine "Biology: The Science of Life," for colleges, says, p. 867, "Darwin's ideas of natural selection and organic evolution . . . were not original with him but were the outgrowth of the ideas of his grandfather, Erasmus Darwin, and other men." It is well known that "the survival of the fittest" doctrine forms a core theme of natural selection. Later, on the page already quoted, we find: "Alfred Russel Wallace . . . also an Englishman, wrote a paper setting forth practically the same views as Darwin on organic evolution." Also on p. 797 there is this: "Alfred Russel Wallace . . . had arrived at essentially the same conclusions."

Fasten's enjoyable "Origin Through Evolution" reminds us that both men had read an essay on population growth and principles by Malthus, though about twenty years apart, which set them thinking upon " . . . the same general principle which underlies the evolution of plants and animals" and for which *both* " . . . must be regarded as the founders of modern evolutionary thought." The outline mentions "Darwin" (all too often grandfather Erasmus is neglected), and "theories of organic evolution."

Discriminatory thinking recognizes that there is the theory, or principle, of organic evolution itself, a great biological concept, commanding almost universal approval by present-day biologists, *plus* those subsidiary hypotheses which are proposed in explanation of the method, course, direction and so on of the great overall idea itself. To which of these very separate, though related, lines of thinking does the syllabus refer?

Charles Darwin made outstanding contributions toward explaining the "how" and the "why" of the underlying truth. Wallace happened to create similar ideas without having done the laborious and prodigious amount of investigation of his contemporary. Fasten says, however, that Charles Darwin "elaborated" upon the evolutionary theme, which had its roots of origin in the imagination and reasoning of the early Greeks. "Elaboration" is a very proper way of characterizing it, *not* origination.

12. "The life function by which plants take in oxygen and release carbon dioxide is . . . "

The nearest approach to this in the outline seems to be "release of heat and energy in plants"; for the syllabus, "all cells must use oxygen for energy." Involving the reverse steps followed by photosynthesis as plant respiration does, there is ample room here for confusion. Too much care cannot be exercised by the teacher in making each process understood and kept in correct relation. Could not a guidance manual for teachers have been a little more explicit and emphatic on this crucial point?

13. "Bacteria that live in symbiotic relationship with clover plants help to add . . . compounds to the soil." (Note place of blank.)

Would "nitrogen," "nitrate," or "nitrite" or some other similar term involving nitrogen have been equally acceptable? The local teacher would be in a position to evaluate. Would a standard headquarters answer be set up for arbitrary recognition? The outline mentions "symbiosis" under "Nutrition"; the syllabus has "bacteria for soil improvement." The topic is rather an important one.

14. "The energy stored in foods came originally from the . . . "

This is a reversion to photosynthesis, is repetitious.

15. "The liquid part of the blood is called . . . "

"Blood constituents in man" appears in the outline. The chemist would prefer "components" in referring to a *mixture*.

16. "The wavelike contractions of the alimentary canal are known as . . . "

Had this read "The principal wavelike contractions . . . " or "The wavelike contractions of the small intestine . . . ," the antiperistalsis of the ascending and transverse colon, an alternative answer possible for "peristalsis," would have been ruled out. Cf. Martin's "The Human Body," p. 531; Howell's "Textbook of Physiology"; Dorland's or Gould's Medical Dictionaries; texts by Stiles, McDougall and Hegner, and others. The outline *mentions* digestive organ functions merely.

17. "In the body, glycogen is stored in the . . . "

Lobsters, oysters, clams, scallop muscles, etc., contain large amounts of glycogen making "body" inexact and indefinite. Howell's "Textbook in Physiology," a leader for many years, says "Muscular tissue, as well as liver tissue, . . . is capable of laying up a supply of glycogen from the sugar brought to it by the blood." "The major organ for storing glycogen in the human body is . . . " would have avoided all discrepancies.

18. "A disease characterized by an abnormal growth of cells is called . . . "

What is the "abnormal condition" of the thyroid in completion question #3 but one of *growth*? What is this property of living things? Pieper, Beauchamp and Frank, in Unit III of "Everyday Problems in Biology," have an excellent discussion. They summarize by listing, in general, four aspects:

1. "the assimilation of non-living substances and the production of protoplasm,"
2. "the increase in the size of the cell or cells,
3. "the increase in the number of cells,
4. "the development, in higher organisms, of different kinds of cells which serve special purposes."

Enlargement of thyroid cells, swollen with colloid secretion which they cannot release, is "abnormal growth." Two pupils with good records in the class for the year cited "goiter" as an answer to this and were refused credit. Consult the average secondary school biology text, with its prominent illustrations of cretins and myxedematous adults, striking examples of abnormalities which, with accompanying descriptions would be ample reason for the citing of this disease.

Investigation showed that "cancer" was expected. Haggard, in "Science of Health and Disease," pages 88–89, presents clearly facts concerning cancerous types of neoplastic growth, both benign and malignant. A very ***rapid rate*** of ***division*** (multiplication) is typical of such tissues which have "run wild." Cell size-increase normally leads to separation of part of the protoplasm because extent of surface exposed is no longer sufficient to provide food intake for total volume needing to be replenished. Therefore numerous conditions of cellular or tissue abnormality would qualify as unusual growth. By phrasing the sentence " . . . abnormal ***rate*** of growth and multiplication of cells," the meaning becomes restricted and "cancer" is definitely indicated. The outline has listed it under "noncommunicable diseases."

19. "The percentage of hybrid offspring resulting from a cross of hybrid parents is . . . "

Since the outline section on heredity is very well done and only monohybrid crosses are called for, the intended answer of "50" would probably be had. But in a two-character cross an altogether different condition prevails in the F2. Parents may be hybrids with respect to an indefinite number of pairs of contrasting traits. Hybrid offspring percentages would vary unless the number of paired characters involved in the cross were specified. Therefore substitute "monohybrid parents."

The outline and syllabus cover the next ten modified-true-false statements fairly satisfactorily. "Leaf modifications," however, seems not to be included. Reference to barberry spines as modified leaves was found in only three of ten standard high school biologies examined. "The spines on a barberry bush are modified leaves," was the example. If incorrect the underlined word, "leaves," was to be changed. Another case read "During the process of mitosis the chromosomes split lengthwise," making no privision here for the exceptional pairing behavior and separation which occurs in the reduction phase of maturation mitoses. A third specimen was that "Fungi reproduce asexually by means of spores." This leads toward thinking that it is the only way. Yeasts, for example, show asexual budding and simple cell division. "One method of asexual reproduction in fungi is by means of spores," and "During the process of ordinary mitosis the chromosomes split lengthwise" would seem to clarify both matters.

Twenty-one multiple choice examples comprise the third part of the first half of the examination. The probable intended answers concern ameba, plant ovary, vitamin deficiency, plasma, the female parent, grafting, reptiles, photosynthesis, the small intestine, axon, poliomyelitis, bacterial action, rest, iodine, the chimpanzee, bile

storage, fibrinogen, assimilation, the salmon, slow reproduction of superior individuals, and the lack of natural enemies as a factor in increased multiplication. It will be seen that several of these have appeared in previous places in altered form, such as the protozoa, thyroid, digestive system, photosynthesis, plasma, bacteria, nerve cells. Some statements could be improved it is felt although the section as a whole is well done. Again the outline and syllabus cover the range with variable adequacy. Tuberculosis merely appears, with infectious disease not emphasized in accordance with its importance. Neither blood-clotting nor cold-blooded animals seem to have proper place in the directions issued. Instance thirty-nine, "The part of a neuron that is covered with a fatty sheath is the (axon)" makes no allowance for the fact that *two* classes of nerve fibers, medullated (fatty-sheathed) and non-medullated, occur in about equal numbers. Nor is the lipoid material present around the whole axon in the medullated fiber. Only after the axon has traveled away from the cell body does it begin to appear.

Introduction of the Kenny treatment would reflect the moving pictures seemingly, although a few texts carry the account. "Human blood resembles most closely the blood of a (chimpanzee)" fails to take account of *various* likenesses, chemical and histological principally. Bloods of man, cat, chimpanzee, dog and rat would all present notable *structural* resemblance. Multiple choice tests are easily marred by the addition of possible choices for a given statement which are so unrelated to the subject as to be glaringly unlikely. This series is very free from that objection. Only here and there do we find an alternative bordering on the too obviously wrong side. One such might be that criminals are the most fertile element in our society. The eugenics sample offers opportunity for some doubt in that it is open to argument as to what constitutes "superior individuals."

Five questions were to be answered from Part II, there being nine in all, a generous choice. Each has from two to eight subdivisions. They are lengthy therefore comment will have to be limited.

A one-celled plant or animal is to be drawn and labeled. Apparently it is for the teacher to decide how fully the labelling is to be carried out. To assist the teacher the outline called for a study of *one* or *more* single-celled animals, and the same for similar plant organisms. In a case of inadequate teaching followed by dissatisfaction on the part of the pupil with grade received and an appeal to a higher official for a recheck, what standard would that second marker adopt in giving his grade?

Seven specific kinds of cells are listed with an important function of four required. Nowhere in the outline does there seem to be provision

made for drill on cambium tissue, as a previous paper has pointed out.

A plant enzyme or plant hormone is to be named and the function given. The topic of plant enzymes is not suggested, that of plant hormones has previously been discussed, in Part One.

A curiously worded question follows. Eight statements, allegedly true, are made. Five are to be chosen with a "reason" given as to "why the statement is correct." First, examination of certain of these "truths" shows that they are not all such.

"The sperm nucleus of a higher plant is only one of the two nuclei of a pollen grain." There are *two* "sperm nuclei," preferably called male gamete nuclei. College botany textbooks by Pool, Darrah, Youngken, Fuller, Haupt, Sinnott, Smith and his associates, will all confirm the assertion. Fuller's "The Plant World," page 320, figures a pollen grain of *Lilium*, in which there are two nuclei, one called the "tube" nucleus, the other the generative cell with its "generative nucleus." When the pollen grain produces its tube the single generative nucleus divides to form *two* male gamete nuclei. Possibly the compilers of the set of questions confused the "mother cell nucleus," as it is also called, with the two products, the male gametic ones, which effect fertilization in the ovule. The pupil is asked to explain why a falsity is correct! Wouldn't you be confused, and if you had taught your class correctly, wouldn't you be more than a little concerned?

A second sentence is "There are more insects in the world than mammals." Now do biologists know exactly how many, by count, there are of insects or mammals in the world? The sentence does *not* read "species." Our class might average fifteen years of age, which would be reasonable for high school sophomores. Are they supposed to interpolate words and meanings into "true" statements in order to make them clear? Or have we the right as teachers and students to expect an official document to be exact and perfectly transparent in connotation and expression? Such a claim as this would be justified only from inference and should be made with the reservation apparent. The number of insect *species* exceeds that of any other comparable grouping among animals. Reproductive rates are high. Egg production is enormous. The *chances* favor the truth of the assertion. But there are many small mammals and many nooks and corners of the earth which they occupy. The number of protozoan species is relatively small as compared with some other animal divisions. Yet it is entirely possible that a total number of *individuals* is far greater than would appear.

In this test section the entire emphasis may be wrong. The pupil's

attention needs to be focussed upon *cases* bringing out a state or condition. It seems much simpler and clearer to ask him to "give a reason for the fact." The pupil could justifiably say, if he were arbitrarily judicial, "That is correct because reliable authorities have said so." Presumably the intent is that those factors which operate to bring about difference in numbers are the nub of the discussion.

A third statement, "Conjugation is a form of sexual reproduction" is, likewise, not clearly expressed, because there is more than one meaning for conjugation. In the conjugate algae the act *is* sexual reproduction itself, not a form of, or variant of, the same. How could a reason for correctness then be given? Secondly, in the conjugating ciliate protozoa it is an occurrence which takes on the aspects of sexual union without being true fertilization where specialized sex cells are produced, either isogametes or heterogametes. Here it could be called *a form of*, or variation from, the customary sexual procedure. One could then explain why it is considered so. We even speak of conjugal bliss among people, signifying a married state of happiness, a union. The term rather aptly describes two infusorians whose oral surfaces are apposed for an interchange of micronuclear protoplasm. The test assumes but one shade of meaning to "conjugation."

Another part of the examination relates to racial and individual change, "The development of an individual seems to repeat the development of the race." This is a re-statement of the "biogenetic law," "Ontogeny repeats Phylogeny," but not a modern interpretation. Again we ask is it appropriate to insert controversial, philosophical issues with which biologists have concerned themselves for many years without final settlement in a test requiring a fifteen-year-old's final sayso? It is certainly permissible to call attention to the general resemblance between chordate embryos, to point out the persistence in the mammal, for example, of remnants that had useful counterparts in racially lower forms, but to lead the beginning biologist to believe that an individual even *seems* to cover phylogenetic history as it matures is to pervert recent views. There are stages *reminiscent of the past* but they are transitory.

"Name two organs of excretion and state a waste given off by each" gives the pupil no inkling as to whether his answers should be limited to the human body or may include the entire range of life. Even plants give off exudates which might be cited.

Seven "procedures" likely to have been carried out as demonstrations, student exercises, or experiments, are listed for a single observation that could be made on each of five. The outline gives the teacher no adequate direction as to what such might profitably be. The syllabus lists numerous possible ones. Of those appearing on the

particular test it mentions action of "saliva on starch" without stating whether raw or cooked is meant. "Capillary circulation" is a second specific manipulation. Fermentation, photosynthetic procedures, and tropisms are general recommendations.

The demonstration of osmosis and a study of stained onion cells, in the test, seem not to be in the syllabus. The student is asked to criticize the addition of saliva to a "starchy substance," with no suggestion as to whether it should be raw or boiled. Saliva will have very little effect, if any at all, on the uncooked starch.

A whole question is devoted to insects, conservation, and economic biology. It is the author's feeling that these important matters are not emphasized carefully enough by either outline or syllabus. Parts of this final portion of the examination are: "Using specific facts, discuss two of the following: (1) the reason for rotation of crops, (2) a method of erosion control, (3) the economic values of forests."

Curtis, Caldwell, and Sherman, in "Everyday Biology," state that "The purpose of crop rotation is to keep the soil fertile." Here "purpose of" is taken to be the equivalent of "reason for." Bayles and Burnett, who have an excellent chapter entitled "To Save Our Land" in "Biology for Better Living," say, p. 129, "Crops should be rotated to help save the soil and to conserve moisture." Here are two *reasons*, both different from keeping the soil fertile. The latter authors spend much time, correctly, in bringing out the importance of soil conservation and the prevention of erosion. This is what they mean by saving the soil.

Farther on in the discussion we find a *third* reason, not formulated in so many words but adequately treated and clearly inferred, the building up of "nitrogen reserves" which is even more specific than Curtis' "soil fertility" idea but practically its equal. Here, then, are *three* excellent reasons in place of *the* reason. Which of them would the sponsors of the test insist that the pupils *discuss*? Would the local teacher have corrected for one only or for any of the trio, all equally valid?

Under "preventing erosion" Curtis, Caldwell, and Sherman cite six "methods which are used in checking." Bayles and Burnett show nine references to pages of the text, in their index, under erosion "controlling," but consider the topic from the standpoint of "soil conservation." They list and discuss at least four of the methods of Curtis, et al. Skilful teaching is needed here to unify, relate properly, and integrate varied and confusing terminology. There is involved, also, the matter of how extensive a discussion would be required. Treatment in various texts ranges from mere listing of the numerous methods, with occasional brief comment, to well developed presentations. It would be incumbent upon the local teacher in grading

his papers to judge whether he had set the matter forth fully or had barely mentioned it, if at all.

Some interesting queries now arise at the conclusion of what might have been a more prolonged criticism. In the previous paragraph we see an instance of the disparity in consideration of a given pertinent topic by two very commendable textbooks. This is bound to happen for several reasons. How do well-organized, tested, high school biologies meet the conditions imposed by such an examination as the official state-administered one of 1947? Also, how satisfactorily did the local teacher, having the benefits intended by the outline, syllabus, and standard texts, prepare his class? It is unfortunate that complete satisfaction cannot be had here as an attempted appraisal is made. Some light can be thrown upon the subject, which is exceedingly important to pupil, parent, taxpayer and community, in the pursuit of improved educational results. Further papers will present and discuss those pertinent facts as they have been made available.

The intelligent reader, whether biologically trained or not, will see at once from what has been shown already that there are inherent weaknesses to be most carefully guarded against in a system which demands that a teacher give a set of questions even remotely like those we have just evaluated. The very least that the supervising department is obliged to do is to ensure, somehow, a paper entirely free from easily correctible mechanical and factual errors.

The intelligent and informed biologist will read such a production with real distress and shaken faith in the intellectual integrity of some of the fellow members of his profession. He will hesitate to expose himself to a role of analyst and critic, yet he will feel, if he cares at all for the ideals of scientific accuracy which he professes, by way of duty, bound to do so. The critics of our schools give free utterance to their opinions all too often. Our job is to see that they have as little justification for complaint as we can.

THREE NEW YAF FILM RELEASES

Young America Films began shipment this month to dealers and schools of three of its new film releases—THE TEEN NUMBERS, SEWING FUNDAMENTALS, and SEWING-SLIDE FASTENERS.

THE TEEN NUMBERS (1 reel, sound, $38.50) is a continuation of the Young America Arithmetic Series. It is an arithmetic teaching film prepared for the Primary Grade level, and is a companion film to such previous releases in this series as WHAT IS FOUR, PARTS OF NINE, PARTS OF THINGS, and MEANING OF PERCENTAGE.

SEWING FUNDAMENTALS and SEWING-SLIDE FASTENERS (each 1 reel, sound, $38.50) are continuations of the Sewing Series begun with SEWING ADVANCED SEAMS and SEWING SIMPLE SEAMS, all designed for Home Economics instruction in high school, trade school, college, and women's groups.

CRITICISM OF CERTAIN ASPECTS OF HIGH SCHOOL MATHEMATICS TEXTS*

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Mathematics has been called by some the oldest science, by others it has been termed the mother of exact science; still others present it as the outstanding example of pure logic. If this be true, one would expect to find clear cut definitions, unambiguous problems, and in general extreme clarity of statement. In many instances the contrary situation is found. Anyone who has reviewed a considerable number of elementary texts is not at all surprised to find an author giving an incorrect or at least an incomplete definition. It may be argued that complete rigor in definition is not always possible when terms are introduced on an elementary level; but in many cases no more mathematical maturity would be required to grasp a rigorous definition than to grasp the definition given in the text. If alternative definitions exist, or if other conditions may be needed for complete rigor, this can be pointed out without further elaboration. For example, even though the student will only deal with right circular cylinders, the definition should not exclude an oblique or an elliptical cylinder. If it seems inadvisable to go this far, why not define a right circular cylinder and if desired, mention that hereafter this will be referred to as a cylinder.

It is planned in this paper to present a miscellaneous collection of illustrations—not of the fact that mathematics is an inexact science—but of the fact that textbook writers and teachers of mathematics are often careless in their statements. Perhaps in some cases you will claim that I am quibbling over minor details—I hold the view that even in minor details we can have exactness and mathematical rigor. In many texts I found no questionable terms or only one or two such items in a careful reading of the entire text; in other cases the points to which I took exception were very numerous. I have deliberately not mentioned texts by name or author, in a few instances I have rephrased the statement to avoid identification of a text, since it is not my purpose to criticize any single text or author, but rather to call attention to a more or less general tendency. All texts quoted were published within the last dozen years. I have attempted to group my comments into a few broad categories; although several items could be classified in more than one category.

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* Read before the Mathematics Section of the Central Association of Science and Mathematics Teachers, November 28, 1947.

Definitions

If alternative definitions exist, even though they may not be as widely accepted, it might be very helpful to the student to point out that in another book or article he may encounter such an alternative. For example, the majority of geometry texts define a circle as: A closed plane curve all of whose points are equidistant from a point called the center (or the equivalent of this definition). Less than half the texts mention that in some texts and under some circumstances *circle* means the portion of the plane enclosed by the curve described.

One would think that the term *mantissa* should have a definite meaning. Most definitions imply, even if not clearly stated, that the mantissa is a number numerically less than unity, that is a fraction, usually a decimal. According to some definitions, the common logarithm of the square root of ten has a mantissa if it be written 0.5000, but has no mantissa if it be considered to be the fraction $\frac{1}{2}$. In other words, the term mantissa is meaningless unless the logarithm is written as a decimal. A more disturbing difference is noted in the two definitions:

A. A logarithm consists of an integral part called the characteristic and a decimal fraction, called the mantissa.
B. A logarithm may be written as the sum of a whole number (called the characteristic) and of a number less than one but not less than zero (called the mantissa).

By definition A, the mantissa as well as the characteristic may be negative; under this definition the mantissa of a common logarithm is not independent of the decimal point. Further statements indicate that the authors intended to allow the definition of a mantissa to include a negative fraction—"for convenience in use of tables, it is desirable to select the mantissa as positive even if the logarithm is negative"; or again—"for practical reasons the logarithm of a number is always written in such a form that the decimal part is positive." *Always* is a strong word; it may be hard to justify in the solution of an exponential equation, and even more so when in the same text one finds the statement $\log 0.15 = -2.096$. Apparently common usage restricts the term mantissa to common logarithms—I am not sure on this point. That such is the intent of certain authors is evident by the definition: logarithms of numbers between 1 and 10 are called mantissas. For common logarithms this is equivalent to definition B. A working rule for the student, rather than a rigorous definition, is the statement, "The mantissa is that portion of a logarithm which is found in the table."

The following statement is taken directly from one text: "The unit of measure of angles is the degree." Would it not be preferable to

state it: "The principal unit of measure of angles is the degree," or, "The customary unit of measure is . . . "?

Another text says: "In measuring the size of an angle the unit is a tiny angle." The work tiny is relative. I may be tiny as compared to an elephant but not relative to a mouse. Moreover, what about the units radian and mil?

A rather commonly encountered definition is: When three or more lines meet at one point they are said to be concurrent. One might wonder why two lines cannot be concurrent.

It is not at all infrequent to find zero and negative exponents defined without any restriction that the base must not be zero. In fact one handbook makes the flat statement that $a^0=1$ even if $a=0$.

At the secondary school level, proof of the relations $x^0=1$ and $x^{-n}=1/x^n$ is not feasible. Yet some texts give the student the false assumption that these relations have been proved, without pointing out the use of a postulate that laws of exponents developed for positive integers must hold for negative and zero exponents. With such a postulate, proof is possible, but the necessity for such a postulate is not always stressed. On the other hand, many texts simply define the relations, first justifying the type of definition by examples. Usually such examples really point out that the definitions adopted are those necessary if operations with zero or negative exponents are to follow laws already developed. Examples of the argument employed do not always lead one to believe that the student is being introduced to a science which uses exact thinking.

In a geometry text one encounters as a definition: An axiom refers to a general mathematical truth; a postulate to a geometrical truth. The student who elects certain courses in higher mathematics will be confused when he discovers postulates in higher algebra. Another text in plane geometry states: "A proposition is a statement of geometric truth. A theorem is a proposition to be proved." Is it any wonder that my students in college algebra are amazed when they meet the factor theorem or remainder theorem? Theorems can only occur in geometry; if they believe their earlier texts.

The following two definitions of a formula appear in two different texts but seem to have the same general idea. "A formula may be used as a convenient rule for the evaluation of any one of the involved quantities in terms of the known or given values of the other quantities." "A formula is a general statement which may be solved for any letter in it." I suggest to the authors of these texts that they might try to solve the formula ${}_nP_r=(n!/(n-r)!)$ for n.

Erroneous or Unqualified Statements

It is indeed hard to know where to draw the line which distin-

guishes between an incorrect definition and an erroneous statement. The classification is frankly arbitrary.

In a business arithmetic I find a description of the check by casting out the nines. Authors fail to mention that this check fails to catch an error of nine in the total, which can readily be caused by transposition or by two errors or unity, one in the tens and one in the units column.

Again I find: Dividing each term of a ratio by the same value does not modify the ratio. (It modifies the *form* but not the *value* of the ratio.)

Very closely related to the preceding statement is the following: "Multiplying or dividing both terms of a fraction by the same number does not change the value of the fraction." What if the number is zero?

From a geometry text: Pi (π) is the ratio of the circumference to the diameter. It equals 3.14159 or 3.1416. (This same text discusses at some length the problem "Determine the ratio of one line to another when there does not exist a common unit of measure." Incommensurable cases are discussed at length; yet here there is no mention of approximation.)

A geometry text states "two circles which do not meet have four common tangents." I grant they may have four common tangents, but they may also be concentric.

A commercial arithmetic reads: "Prices on the installment plan are naturally higher than cash prices." At least two stores in my home town charge exactly the same for a cash purchase as for a purchase on the installment plan. Several items are sold at the same nationally established price as in stores which extend no credit. These two stores would challenge the accuracy of the statement in the textbook.

In discussing logarithms one text reads: "Any number except one could be used as the base of a system of logarithms." What about zero?

When I find the statement: "-5 times $+6 = -30$ because -5 times any number must be the opposite of $+5$ times that number," I frankly am not just sure what is meant.

"If $x=3$,

$$\frac{x^2-4x+3}{x^2-5x+6}$$

is the indeterminate form 0/0. By reducing the fraction to its lowest terms

$$\frac{(x-3)(x-1)}{(x-3)(x-2)}=\frac{x-1}{x-2}$$

and then substituting we obtain 2/1 or 2." The author completely overlooks the fact that he has violated his own rule that dividing by zero is prohibited.

The following example seems to be an error pure and simple. It has proved, however, very confusing to students who have tried to follow the explanation.

Find the product of 37 and 63 mentally:
Solution: Since $37=30+7$ and $63=60+3$, the product involves the following simple mental steps:

$30\times60=1800$	
$30\times\ 7=\ 210$	$1800+210=2010$
$60\times\ 3=\ 180$	$2010+180=2190$
$7\times\ 3=\ \ 21$	$2190+\ 21=2211$ *ans.*

The preceding error occurred in the first edition of a text. Much less excusable is an error which has been repeated in at least three successive revisions of a rather widely used text. In an illustrative problem showing computation by logarithms the given data include $c=0.46330$; in the solution the value used is $c=0.04633$.

"If one parenthesis incloses another, the inner parenthesis should be removed first." Is this a rule, or a matter of choice?

In illustrating area by counting on squared paper, "20 squares are wholly inside a triangle; 22, half or more than half inside; 17, less than half inside, we disregard these. The area of the triangle is therefore 22+20 or 42 square units." At no place is it mentioned that this is approximate—the student is asked to *agree* to the method.

An arithmetic states: Sir John Napier in 1600 was the first writer to use the decimal point as we use it today. Sanford in her *History of Mathematics* says that Burgi did this in 1592 and that Napier used a comma rather than a period. Cajori likewise points out Napier's use of a comma.

I am not sure that every branch of science would agree with the following statement from an elementary mathematics text: "When an important conclusion is made in any branch of science it is first written in the form of a rule and then reduced to a symbolic expression called a formula."

The following rules for solving worded problems are given in an algebra book:

> Read the problem very carefully.
> Using symbols, express the number we know least about, calling it x.
> Represent all other numbers in terms of x.

In addition to the difficulty of determining which number we know

least about, this assumes that all numbers in a problem are pertinent to the solution. This assumption is unfortunately only too true in the large majority of problems encountered in text books. Very rarely in actual life do we encounter a problem which does not involve extraneous data. Several such problems might be of distinct value; if nothing else, it would be possible to list all needed data for a series of problems at the top of the list of problems.

A very common problem found in algebra books is one of the type—"If the parcel post rate is eleven cents for the first pound and five cents for each additional pound write the formula for the postage "p" on a package weiging "w" pounds." The common answer is $p=11+5(w-1)$. This formula is incorrect for any weight not an integral number of pounds. Without specialized notations not usually encountered in secondary school work, it is not feasible to write the formula asked for. An equally serious error is to graph the cost as a linear function of p and w. Actually this is an excellent example of a discontinuous function. The graph consists of a series of line segments parallel to one of the axes.

"Sixty has two significant figures." I can find no other discussion of significant figures in the book nor is the topic in the index. How was it determined that the zero was significant and did not merely locate the decimal point?

Several statements occur in connection with trigonometry. In some cases these are taken from trigonometry texts. In others they appear in the section of a geometry text entitled *Numerical Trigonometry.*

"This ratio is used so much in trigonometry that it is called the *tangent ratio* and is abbreviated 'tan.' " I object to two points. In all work in trigonometry, I find this function called tangent, not the tangent ratio. Secondly, the abbreviation is not tan. since there is no period.

"The tangent of an angle is the ratio of the side opposite the angle to the side adjacent to the angle." Side of what? At no place does this definition mention a triangle.

These two statements are from a plane geometry text: "The sine increases when the angle increases." "The cosine decreases as the angle increases." Granted the discussion in this text is limited to acute angles, why not say so in these statements?

"If $\sin\theta=\frac{1}{2}$ what is the value of θ? Ans: $\theta=30°$, 150°, 390°, 510°, etc. It is customary to list only angles between 0° and 360°, that is, principal values." This is if not an erroneous at least an unusual use of the term principal value.

"If we try to show that the amount spent for food this year is twice that in 1930 by use of circles, one of which is twice as large as the other, we may deceive the reader since areas of circles are not proportional to their radii." I agree. Continuing, "It is interesting to note that the circles more truly represent the situation when they are drawn as in Fig. II rather than Figure I." I fail to agree. It may be the public is less likely to be deceived, but the representation is just as true in one case as in the other.

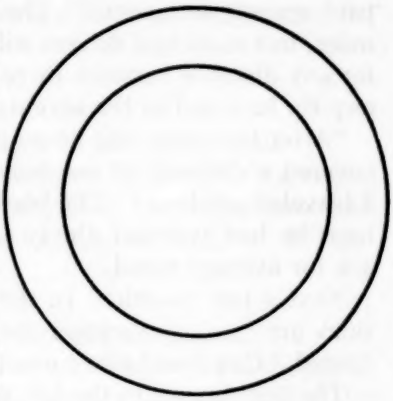


FIG. I

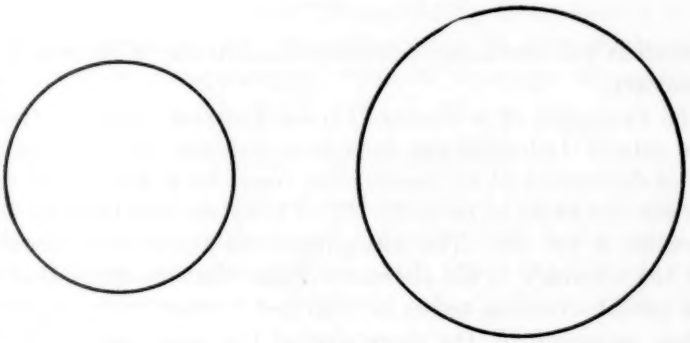


FIG. II

Perhaps I overlook the purpose, but when propositions on two succeeding pages each use the other in the "proof," I fail to follow the logic.

INDEFINITE OR AMBIGUOUS PROBLEMS

It is not unusual to encounter a problem which has either insufficient data given to allow an answer to be found or the answer is ambiguous. A few illustrations will suffice.

Problem from geometry:

A baker sold pies eight inches in diameter for twenty cents each; eleven inches in diameter for forty cents each. Which was the better bargain?—You tell me if the thickness was the same, then I shall answer: unless I believe cherry pie a better bargain than apple.

"If taxicabs charge fifteen cents for the first one-fourth mile and five cents for each additional one-fourth mile, how far did I ride if I

paid seventy-five cents?" The text answer is three and one-fourth miles, but most taxi drivers will make a charge of seventy-five cents for any distance between three and three and one-fourth miles. Was any tip included in the seventy-five cents?

"After traveling four hours in my automobile, I found that I had covered a distance of one hundred sixty-eight miles. How fast had I traveled per hour?" The book gives forty-two miles per hour. Perhaps he had traveled ninety miles per hour. The problem did not ask for average speed.

Next a test question: In the same triangle, angles opposite equal sides are _____. Perhaps the intended word to fill the blank is "equal." Can it not also correctly be "acute"?

The text answer to the following equation is $x=2$:

$$\frac{x}{x-2}+\frac{3x^2+6x-32}{x^2-4}=4$$

The student will encounter considerable difficulty if he tries to check this answer.

"The navigator of a Boeing 'Flying Fortress' flying horizontally at the rate of 180 miles per hour in a straight course observes the angle of depression of an observation tower on a flying field directly below his line of flight to be 25° 25′. Thirty seconds later its angle of depression is 43° 29′. The navigator uses these measurements to check the accuracy of his altimeter. Show that his calculated height above the observation tower is 7543 feet." Were both angles of depression measured on the same side of the tower or had the plane passed over the tower during the thirty seconds?

In one text a problem required the solution of a quadratic equation to determine n, the number of terms in an arithmetic progression. The roots of the equation were $5\frac{1}{2}$ and -23.

In a recent text in spherical trigonometry one finds a vessel sailing across the equator in longitude 78° 26″ W. The fact that this point on the equator is about one hundred miles inland does not help the student gain confidence in the author's ability as a navigator.

Notations and Conventions

The following examples are representative of notations or conventions which are to a greater or less degree not in common use. Without criticising such notations one may question the advisability of training the student in the use of a notation or terminology which may cause him difficulty later.

$\|$ is parallel to

$\overset{\circ}{=}$ is equal in degrees to

$P_b{}^a$ projection of line segment a on b

An arc must be read counterclockwise: AB is a minor arc; BA is a major arc

P_{10} perimeter of a 10 sided polygon

$\overset{m}{=}$ is measured by

-2.3010 for $\log_{10} 0.02$ rather than $-2+.3010$ or $\bar{2}.3010$

"The word *cancel* can only mean division. Example: We cancel two from the expression $2x/4y$. Annul should be used when we eliminate the 2 from both sides of the equation $x+2=3y+2$."

$\llcorner$ right angle

$\doteq$ approximately equal to

2^r 2 radians (in another text this means 2 revolutions)

The November issue of SCHOOL SCIENCE AND MATHEMATICS has an article on slide rule instruction which suggests the term "ligit" for the number of places to the left of the decimal point. If such a term is needed, by all means let us unite in an attempt to achieve its widespread use; if this is not feasible or particularly to be desired, we may question the advisability of using the term. In later work will the student be aided or be confused when he no longer encounters the term?

SUGGESTED MODIFICATIONS

It is quite annoying when in attempting to locate a topic in a textbook the subject in question is not mentioned in the index. As a example, consider a geometry book which treats the following terms or concepts but omits them from the index: interior angle, bisect, concurrent, decagon.

In introducing negative numbers one frequently finds as an illustration the example of dates B.C. and A.D. This may be an unfortunate choice. There is no zero on the scale, hence the elapsed time from a specified date in the year 1 B.C. to the same date in the year 1 A.D. is not two years but one year.

It is quite common to find the earth's orbit given as an example of an ellipse appearing in nature. Unfortunately most diagrams of the orbit are badly distorted. The eccentricity is so small that a drawing to scale is hard to distinguish from a true circle without the use of a ruler. Check this with the usual diagram of your texts.

In the introduction to the study of logarithms it is quite common to find such problems as the following: Given that $\log 2=0.3010$, $\log 3=0.4771$, and $\log 7=0.8451$; find by use of the properties of logarithms $\log 6$, $\log 42$, $\log 49$, etc. Frequently the student obtains the answer by use of the tables rather than by making use of the properties of logarithms. If the given logarithms were natural rather than common logarithms or, even better, logarithms to the base 8, the use of the tables would not have been feasible.

In the discussion of statistical graphs the student is shown how to draw a circle graph or pie chart. He obtains the proper number of degrees for each sector by taking the required percentage of 360°. As an exercise in arithmetic this may be valuable. I fail to find a single text which points out the existence of a protractor graduated in per cent rather than in degrees. Yet such protractors are in use commercially.

Many textbooks refer to Hero's formula for the area of a triangle. Properly it would seem credit for this formula belongs to Archimedes. This point was again emphasized in a note in SCHOOL SCIENCE AND MATHEMATICS for June, 1947.

The following, taken from an algebra text is said to be a proof that $x^0 = 1$

$$x^2 \div x^2 = 1$$

and

$$x^2 \div x^2 = x^{2-2} = x^0$$

then

$$x^2 \div x^2 = x^0 = 1$$

I believe it would be preferable to call this a justification of a definition. As a *proof* it ranks with the following:

$$a^0 = 1$$

$$b^0 = 1$$

hence

$$a^0 = b^0$$

and $a = b$, irrespective of the values of a and b.

In presenting solutions of simultaneous equations it is common to find preceding a set of problems: "Solve graphically and algebraically." This would imply that a graphic solution is not an algebraic solution. Perhaps a more fortunate choice of wording is possible.

It is perhaps daring to even mention the point, but one may well question in plane geometry the validity of a superposition proof which requires that the triangle be turned through a third dimension. How does one justify this in view of the fact that we have restricted ourselves to two dimensions?

There has been considerable discussion on the topic of order of operations. For example, what is the value of the expression: $36 \div 2 - 3 \times 5$? Whether or not it is worthwhile to introduce such a problem is quite debatable. In how many cases did you ever encounter such a problem without parentheses clarifying the ambiguity?

There is, however, one situation where we may need to use more care. Frequently in typed copy—sometimes in printed copy—one meets the expression: $a/b+c$, which sometimes means $(a/b)+c$ and again means $a/(b+c)$. There is no reason to expect the student to remember a certain specified order of operations when a clear cut notation is available.

SUMMARY

There has been no attempt to cover all types of errors nor is it to be expected that everyone will agree with many of the points raised in this paper. It is not claimed that mathematics is not an exact science, but perhaps enough illustrations have been presented to indicate that although mathematics is an exact science it is not at all unusual for the careless teacher or author to use inexact terminology.

THE SEPTEMBER TORNADO AT NEW ORLEANS

From a letter to the Editor by

JULIUS SUMNER MILLER

This area, the college campus, was in the middle of the whole thing, and I had a wonderful opportunity to observe a hurricane at its best! Meteorologically, the event was beautiful, but as with poison ivy, I prefer another time to observe it from afar! On the Beaufort Scale the wind here was way over Number 12. The cloud formation from cirrus to very dense cumulonimbus was beautiful to behold, but frightening. The impact of the rain was formidable. Whole trees were uprooted right in front of the house. One willow some 4 feet through at the butt was practically picked up. Her branches offered a full sail to the wind and rain. All those trees felled by the storm were headed southward when the calm came. This calm lasted about 45 minutes and there was a deathly stillness to everything during this time. AND THEN—it was as if a huge blower were turned on at a point dipole to the original direction of the storm. The wind came up with such suddenness that there was absolutely no warning—and it came from the south. The felled trees were picked up and turned through 180°. This wind lasted about three hours and bore only slight rain, but what water did fall was very penetrating by virtue of the wind velocity. The destruction in this city was extreme. Many lost their lives. Nearby here several members of one family were drowned.

TOBACCO WITH 10% NICOTINE PATENTED

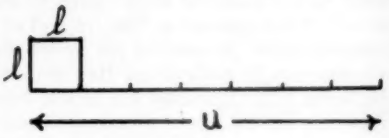
Finely-ground tobacco so strong in nicotine that not even the most confirmed snuff addict would ever dip or chew it—not more than once, anyway—has just been patented here as a possibly profitable commodity. Intended for poisoning insects, it has had its natural nicotine content stepped up to 10% by the addition of straight nicotine sulfate. The pulverized leaf and stem tissue serves as an efficient and low-cost carrier, in place of the mineral dusts hitherto employed.

The inventor of this new natural insecticide, Robert B. Arnold of Richmond, Va., has assigned rights in his patent, No. 2,431,672, to the Tobacco By-Products and Chemical Corporation.

THE IDEAL GAS LAWS

GEORGE ANTONOFF AND DUNCAN RANDALL
Fordham University, New York, New York

The kinetic theory of gases which is now generally accepted teaches us that the ideal gas consists of individual particles having mass but like a mathematical point, having no dimensions; they do not excercise either attractive or repulsive forces on one another. They are endowed with kinetic energy, and when they strike the wall of the vessel containing them, they behave like a perfectly elastic body, i.e. they rebound from the wall without loss of momentum and thus there is no dissipation of kinetic energy into heat. It is a kind of three-dimensional billiard ball game. The force on the wall during a collision equals the change of momentum. At the moment of impact the velocity $=0$, and before the particle gains its uniform velocity there is an acceleration available, without which one cannot speak of a force in the sense of Newtonian mechanics. If before the collision the momentum was mu, after collision it becomes -mu (m x -u), and the change of momentum is 2mu. This is the momentary force on the wall produced by a single particle. The total pressure will be proportional to the number of hits per second. The number of hits is proportional to the velocity. Thus the pressure exerted by a single particle will vary as the square of the velocity. This becomes clear if we look at the drawing. Let u be the distance covered per second, i.e. the velocity of the particle, and l the length of the cube containing the gas. It is obvious that the number of hits on a pair of walls will be u/l. Thus the average force $=2mu.u/l$. The pressure also will be obiously proportional to the number of particles present. When their number is small, the pressure will not be a definite parameter (measurable quantity) because at times between the hits there will be no pressure at all. With an increased number of particles the pressure will become a more or less stabilized magnitude, although strictly speaking it will always fluctuate. These fluctuations, however, in the case of gases cannot be detected experimentally. The kinetic theory of gases which led to the above concept permits on a purely theoretical basis the deduction of a number of simple laws which are in accordance with experimental evidence to a certain extent, but not perfectly, because real gas particles have dimensions, they excercise attractive forces, and quantum theory recognizes also the existence of repulsive forces. This agreement of ideal gas laws with experiment is sometimes extremely poor, and good results can be expected only in



a state of extreme dilution, when the factors just mentioned do not make themselves felt appreciably.

There is, however, another question which presents difficulty to students even in case of ideal gases. During many years of teaching many people have observed that nobody has a clear idea about the so-called "equation of state," its physical meaning, and the way it can be deduced. The object of this article is to clarify this point.

Boyle's law: for an ideal gas, the volume V is inversely proportional to the pressure P at contant temperature t. Its mathematical expression is

$$PV = K, \quad \text{or} \quad V = K\frac{1}{P}. \tag{1}$$

The curve is an equilateral hyperbola (fig. 1, Getman-Daniels, p. 15 VII Ed. 1941, John Wiley & Sons). V plotted against the reciprocal of P gives a straight line which means that linear interpolation or extrapolation is possible.

Gay-Lussac's or Charles' law:

$$V_t = V_0(1+at) \tag{2}$$

at contant pressure, where V_t is the volume at any temperature t, V_0 is the volume at 0°C., a is the coefficient of expansion $= 1/273 = 0.00366$. This figure has been established experimentally.

According to another variation it can also be stated as

$$P_t = P_0(1+at)$$

where P_t is the pressure at any temperature t, P_0 is the pressure at 0°C, and a is as above. This is the case for constant volume.

Equation (2) can be transformed to

$$V_t = V_0\frac{273+t}{273}.$$

This equation is rectilinear; it shows that at 273° below 0°C., $V_{-273} = 0$. This temperature is called the absolute zero of a scale known as the absolute scale, and its degrees T are obtained by adding 273 to the Centigrade temperature, i.e. $T = t + 273$. Thus,

$$V_t = \frac{V_0}{273}T \tag{3}$$

In the future, the subscript$_t$ will be omitted.

Equation (3) means that, as $V_0/273 = K$, $V = KT$, i.e. the volume is proportional to the absolute temperature; or, $P = KT$.

Up to now, we have used an arbitrary volume V; thus the constant

K as in the expression of Boyle's law, is only constant for this volume. Referring to gram molecular volumes (22.4 liters) we have

$$V=\frac{V_0}{273}T \tag{4}$$

where

$$\frac{V_0}{273}=\frac{22.4}{273}=\text{a universal constant}$$

$$=0.082 \text{ liter/degree/mole}$$

which is the increase of volume per degree; i.e. V $=0.082$ T. For one gram mole of a gas the expansion between 0° and 1° is

$$V=V_0(1+1/273)$$

$$=V_0+V_0/273$$

or

$$V-V_0=V_0/273$$

$$=22{,}400 \text{ ml.}/273$$

$$=82 \text{ ml./deg.}$$

The expression (4) will be correct if we multiply both sides by P_0, which in these experiments is equal to one atmosphere. Then

$$VP_0=\frac{V_0P_0T}{273} \tag{5}$$

where ($V_0P_0/273$) is a constant numerically equal to the constant of equation (4), but having different dimensions, namely

$$\frac{22.4 \text{ /mole}\times 1 \text{ atmos.}}{273^\circ}=0.082 \text{ liter atmos. per deg. per mole.}$$

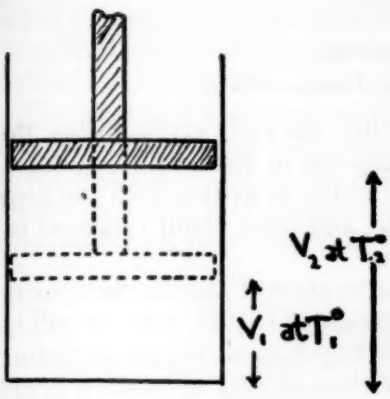
The convention is to call this universal constant R.

In words, R is the work of expansion of a gram molecule of a gas obtained by a temperature rise of one degree.

It is obvious that if equation (5) is valid for two given values of VP_0 at a given temperature, it must also be valid for all values of PV at the same temperature by Boyle's law. Thus there can be shown to exist the law

$$PV=RT \tag{6}$$

which we will call the equation of state for a perfect gas. The product



PV is an expression for work, as can be seen from the following: imagine a vessel with a frictionless piston, which we have moved a distance dl; the small work dW = force x distance; the pressure = force per unit area, by definition; the cross-section of the vessel, or the area, = S; thenwe have dW = PS dl; but s dl is an element of volume, whence PdV = dW For the total work,

$$\int PdV = \int dW, \quad \text{or} \quad W = PV + \text{const.}$$

If the expansion is done at constant pressure from volume V_1 to volume V_2 by adding heat so that the piston moves up and remains in equilibrium with the atmospheric pressure,

$$P\int_{V_1}^{V_2} dV = \int dW$$

Or

$$\begin{aligned} W &= W_2 - W_1 \\ &= (PV_2 + \text{const.}) - (PV_1 + \text{const.}) \\ &= P(V_2 - V_1) \end{aligned}$$

where $V_2 - V_1$ is the volume increase due to expansion; thus, W = PV is the work necessary to create a volume V by expansion of the gas.

Let us not confuse this case with the following: if instead of a gas we had in the cylinder a liquid in equilibrium with its vapor, the whole system being immersed in a thermostat, then by moving the piston up we can produce expansion at a constant pressure isothermally. In this case P can be brought outside of the integral since P remains constant throughout the whole operation while there is a liquid phase present.

In still a third instance, in which both P and V are variable, integration is possible only if P is a known function of V.

The radio and the press have done a splendid job in publicizing the educational crisis in the past few years, and they are continuing to do so with a new campaign in the next few months.

MARS

JOHN STERNIG
Glencoe Public Schools, Glencoe, Illinois

1948 brings the planet Mars back into the early evening skies; the planet whose very name rouses a response in folks who may know nothing else about astronomy. This article is written with the hope that many readers may look for, find, and think about this most interesting member of the solar system.

The accompanying chart shows the location of Mars in the constellation of Leo on January 30 and February 17, 1948. Since it will be located near the first magnitude star Regulus and the planet Saturn it should be very easy to find, for the three objects will make a bright and distinctive conformation in the eastern sky about nine o'clock in the evening during February. Mars and Saturn are both in retrograde motion in February. This accounts for their movement *westward* as shown on the chart.

Mars will be at opposition (opposite the sun) on February 17 at which time it will be closest to the earth; about 63 million miles, and will shine more brightly than any of the stars. However this opposition finds Mars relatively far from earth. It can come as close as 35 million miles when the two planets are opposite each other at the point where their orbits are closest. The 1948 opposition finds them where their orbits are farthest apart.

A few "vital statistics" on Mars now follow:

Diameter 4,215 miles
Average distance from sun—141 million miles
Closest distance from earth—34,600,000 miles
Sidereal year—687 days
Rotation period (day)—24 hours 37 minutes 22.58 seconds
Gravity—.38 that of earth's
Inclination of axis—24 degrees (Makes seasons like earth's)
Moons—Two; Diemos and Phobos
Temperature range—plus 70 degrees to minus 90 degrees

To anyone having access to a telescope of at least 100 power Mars offers much that is worth observing. It shows a distinct disk, reddish ochre in color, marked with hazy areas of a darker hue. The polar cap also shows up clearly. Of course more detail and color is seen as the quality and size of the telescope is increased.

Astronomers have seen such a wealth of detail on the disk that Mars is quite completely mapped. The photograph of the model globe will give some idea of the detail now recognized. This model was made by the author, based on maps by Percival Lowell, one of the world's foremost Mars observers.

Three fourths of the surface of Mars is desert, reddish in color because of oxidation compounds resulting from the chemical combi-

nation of surface materials with oxygen from the planet's atmosphere. As a result very little oxygen remains in the air; less than on top of our highest mountains.

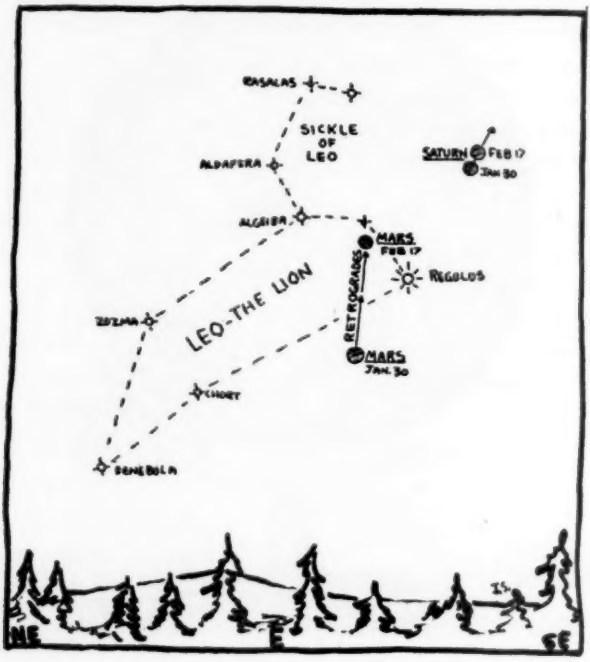
The other fourth of its surface is made up of dark areas, thought by many authorities to be vegetation of some sort. These areas are green in color at the height of the growing season, fade to brown in the Martian autumn, and to grey in winter. As this seasonal change progresses in each hemisphere the polar snow cap also changes. It is

largest in winter, melts to almost nothing in the summer and then grows to maximum size again. Water melting from the snow caps seems to be the source of moisture for the vegetation, though how it gets where it is needed is still a matter of considerable dicussion and speculation.

The famous canals of Mars are not likely to be seen by the ordinary observer though more and more astronomers now feel they are real surface features and might conceivably be the means of getting water where it is wanted. However, agreement about canals is not universal even yet.

Shiaparelli first discovered the canals in 1877. Lowell mapped them very completely in this country in the early part of the century and they have been the subject of observation and discussion ever since.

It was only recently that astronomers agreed on their objective existence, though their interpretation is still an open question. Much of the doubt about the reality of the canals was due to the fact that these features are on the limit of visibility for the very best observers and require critical conditions optically, atmospherically and in telescopes for seeing them. In addition much unfortunate and unprofessional personal spite and even malice entered into the discussions. This is revealed when one reads extensively in the literature on the subject of Mars.



The many conflicting statements in text books show that this has not yet been cleared up. However, the latest writings, when they are not merely copied from older sources; agree that the canals of Mars are real surface features. Thus far the evidence is largely visual though some of the Lowell Observatory photographs indicate canals. If and when photographs finally show them clearly and distinctly as straight lines and arcs of circles, there will probably be no escape from the conclusion that they are artificial and evidence of intelligent life. Perhaps the new 200 inch Palomar reflector will give some answers, though it is designed for use on problems of outer space rather than "local," solar system affairs.

At one time Mars was probably very much like the earth, but as

the ages went by it gradually lost most of its air and water. There are no permanent bodies of water on the planet though the polar caps are surrounded by what seems to be open water as they melt. It is conceivable that organisms might adjust to lessening air over great periods of time, but one can easily imagine the desperation of the inhabitants over lessening water supply as the planet became a desert. They might well have united their efforts to devise some means of utilizing every possible source of it, even to the point of constructing a planet wide system of canals to bring it from the poles, as Lowell suggested. What is seen from earth are likely not the actual waterways but rather the strips of vegetation which parallel them. Whatever the explanation, it is fascinating to think about.

Mars seems to be a living prophecy of the earth in the far distant future. The planet is far gone physically and any life upon it may be in the final stages. What will earth men do when our planet reaches that state? Will we look toward Venus which may then be as Earth is now? And will we attempt to reach and colonize it? How about the possible Maritians? Are they looking toward earth with such thoughts even now? H. G. Wells's *War of the Worlds* may someday be more truth than fiction. After all—guesses, facts, theories, speculation and outright fiction can get easily mixed up when one thinks along these lines.

Since this article is obviously incomplete it might be well in closing to list a few references for the benefit of any one interested in reading further about our red neighbor in space.

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Only slightly more than half the population of the United States 20 years old and over had completed the equivalent of the first year of high school by April 1947, according to estimates just issued by J. C. Capt, director, Bureau of the Census, Department of Commerce.

Great lives never go out. They go on.

BENJAMIN HARRISON

HORTICULTURE FOR HIGH SCHOOLS

JOHN W. RAY
The School District of the City of Erie, Pa.

Horticulture as an elective science has been a part of our course of study in the secondary schools of Erie, Pennsylvania for a number of years. In two of our senior high shools we have greenhouses which provide a laboratory for this course. During the fall semester most attention is given to growing flowers. It is interesting to have flowers blooming in mid winter. They can be used for many school functions. The spring semester devotes full time to growing plants for gardens. The laboratory is divided into small sections to accommodate each student. A few minutes each day is used to care for the plants and when the schools are on vacation some students who live near the school arrange to care for watering the plants.

This course has proved so popular that the science committee when revising the courses in science dropped botany entirely and kept horticulture. It is offered to those students who have studied biology but do not wish to take physics or chemistry. Facilities are so limited that we cannot care for all of the applications. It is limited to the eleventh and twelfth grades.

The course teaches some elementary botany but stresses those facts which bear most on the side of horticulture. Such topics as preparation of the soil, planting, transplanting, care of the soil, use of water and fertilizers, control of insects, grafting, budding and pruning, are studied thoroughly. Particular emphasis is given to the production of fruit and berries. The classes make trips to nearby orchards and greenhouses where they see at first hand what is taught.

This course seems to be well suited for our district. A considerable part of our population is engaged in growing fruit and berries. We have many greenhouses. They have been securing help from our schools for years. It was this condition which caused us to consider teaching some course which would aid those students.

Horticulture should appeal to farming areas, especially those districts where vocational agriculture is taught. The students can learn so many things that they can use on the farms. This new information would cause many students to establish a keener interest in the farm and garden. Many of them who are looking forward to city life might become convinced that they can do better on the farm.

While the people in the agricultural areas will probably benefit most from horticulture, now and then we have city youngsters who are turning their interest to the great outdoors. A few are planning to study agriculture in college with the hope that they may have a farm of their own some day. It would be interesting to know what percen-

tage of county agricultural agents grew up in the city. Whether or not they reach the important jobs is of little consequence. Many of the city children have summer homes and gardens where they can put into practice much that they learn in the course of horticulture.

ELEMENTARY DERIVATION FOR COMPLEX EXPONENT

WILLIAM R. RANSOM
Medford Post Office, Tufts College, Mass.

After C^m has been defined for $m=1, 2, 3, \cdots$ (the counting numbers) it is proved that for such numbers $C^m \times C^n = C^{m+n}$, and from this formula are derived interpretations for exponents that are zero, rational fractions, and negatives; it follows also that $C^{x+yi} = C^x C^{yi}$, leaving C^{yi} still to be interpreted.

C^{yi} is usually defined by putting $z = yi$ $(ln\ C)$ in the power series for e^z. This method involves a considerable study of the calculus. But more elementary considerations can be used, and the one which follows is heuristic and involves an interesting way of introducing the number e.

If we assume that C^{yi} is a complex number, $C^{yi} = p+qi$, it follows that $C^{y(-i)} = p-qi$; then, multiplying, we get $C^0 = 1 = p^2+q^2$. Hence p and q are sides of a right triangle whose hypothenuse is 1. Let us represent by β the angle opposite q; if p and q are sign-bearing quantities, β will be taken in the proper quadrant to make $\sin \beta = q$ and $\cos \beta = p$. Then we have $C^{yi} = \cos \beta + i \sin \beta$.

Squaring, C^{2yi} can be transformed to $\cos 2\beta + i \sin 2\beta$. This suggests that C^{nyi} may be equal to $\cos n\beta + i \sin n\beta$, and an arithmetic induction readily verifies this equivalence for n equals a counting number. We conclude that β is proportional to y, and write $\beta = ky$, and $C^{yi} = \cos ky + i \sin ky$, with no assumption as yet about the units in which the angle ky is measured.

Changing by means of half angle formulas we get

$$C^{yi} = 1 - 2 \sin^2 (ky/2) + 2i \sin (ky/2) \cos (ky/2)$$

whence

$$C^{yi} - 1 = 2i \sin (ky/2) [\cos (ky/2) + i \sin (ky/2)]$$

and

$$\frac{C^{yi}-1}{yi} = \frac{\sin (k\nu/2)}{(ky/2)} \cdot k \cdot C^{(kyi/2)}.$$

From this formula, by means of limits, we can show that if $C=e$, and the angle is measured in radians, the proportionality constant, k, will be equal to 1.

At the beginning of a table of common logarithms, we find that when s is very small, an interpolation formula for $\log(1+s)$ is $s(.4343)$ $=s(\log 2.718)=\log(2.718^s)$. By means of this formula we can construct a table of powers of 2.718, taking $2.718^s=1+s$, and for this table we shall have the formula, for small values of s,

$$\frac{2.718^s-1}{s}=1.$$

Let us define the number e, whose value is evidently approximately 2.718, by means of the limit

$$\lim_{s\to 0}\frac{e^s-1}{s}=1.$$

This definition of e has been found useful in other invesigations: from it the derivative and power series for e^z, and thence an accurate value for e, are readily deduced.

If we return to the formula for $(C^{yi}-1)/yi$, we must make the assumption corresponding to the one that uses a power series for e^z and puts $x=yi$: that is we must assume that the limit formula just derived holds when $s=yi$. There are four factors in this formula. The limit of the fraction on the left is 1 if we take the value e for C. The limit of the fraction on the right is 1 if we measure the angle in radians. The limit of the exponential on the right is $C^0=1$. So the constant, k, must be equal to 1, for $C=e$, and a radian-measured angle. We conclude then that

$$e^{yi}=\cos\,(y^{\text{radians}})+i\,\sin\,(y^{\text{radians}}).$$

Since any complex number, $a+bi$, defines a radius, signless $R=\sqrt{a^2+b^2}$, and an angle, β radians, for which $\cos\beta=a/R$ and $\sin\beta=b/R$, we have $a+bi=R(\cos\beta+i\sin\beta)=Re^{\beta i}$, the rectangular, polar, and exponential forms of the complex number.

OXYGEN IS CONCENTRATED IN EARTH'S OUTER SHELL

Oxygen, which makes up 90% of the solid part of the earth by volume, is most highly concentrated in the earth's outer shell. The amount of oxygen decreases with depth into the earth, explains Tom F. W. Barth, University of Chicago geologist.

If highly oxidized surface rocks were taken down to great depths in the earth, the oxygen would be squeezed out and returned to the surface.

TEACHING THE CHEMISTRY OF FUNDAMENTAL INORGANIC CHEMICAL REACTIONS CAN BE FUN*

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"Do not then train boys to learning by force and harshness; but direct them to it by what amuses their minds."—Plato

Yes, the teaching of fundamental chemical reactions in inorganic chemistry can be fun. And, best of all, these seemingly many and intricate reactions that forever bother students of chemistry can be simply organized and taught from *one* chart. But, that's getting a bit ahead of our story. After some years of teaching the chemistry of the various reactions a beginner in the field should grasp, students have continued to ask the proverbial questions: "What are the important reactions? Could you sum them up for us? Do we have to know all of them? Is there any place we can find them without looking through the entire text?" Although most texts classify the various *types* of reactions into 1. Composition, 2. Decomposition, 3. Single Substitution, and 4. Double Substitution reactions, no real attempt is made to link these basic reaction types to the many reactions of actual chemistry to follow.

In other words, it appeared that a good teaching bet had been lost by not following though these chemical reaction types which had been studied. Further, inasmuch as this lesson falls into the football season (and what young man or woman isn't more interested in football than chemistry at that particular moment), a very interesting analogy can be drawn between basic football formations and these basic reaction types.

One doesn't have to wait for interest and attention very long once the teacher opens a discussion of the "T" formation, the "single-wing" or the "double-wing" in a chemistry class. But, therein lies the significance of our basic chemical reaction types. Composition, Decomposition, Single Substitution, and Metathesis are immediately likened to these basic offensive football formations. (Ah, dreamy eyes are opened just a bit wider, attention "quickens"—maybe this stuff called chemistry isn't as dry as bone.) These basic chemical reaction types are the "formations" of chemical reactions. Hundreds of equations or reactions can be "run" off of them just as hundreds of spectacular plays can be executed from the "T" or the "single-wing." Further, need one mention the fact that immediately the student

* Based upon the text *The Science of Chemistry* (unpublished manuscript).
Read before the Chemistry Section of the Central Association of Science and Mathematics Teachers, November 28, 1947.

realizes the significance of knowing the basic reaction types—after all, anything as important as basic football formations must be really worth knowing.

But, our story does not stop here. At this point the chart of fundamental inorganic chemical reactions is introduced as a wall chart form of visual aid. Individual student charts already punched to fit and fold neatly into the conventional three-ring notebook are distributed. The drama of introducing on one simple chart all of the actual chemistry of reactions the student is required to know for the *entire* year is surprising indeed to the student. Here is finality. Certainly, this is not a course of chemistry on one chart, but it is a summation of the specific reactions to be known and studied. Here is a well-organized system of formations and the "plays" run from them. At this point in the course, the chart instills confidence in the student who is just a little shaky at the moment after hearing about those "hundreds of reactions" a chemistry student will be required to know.

The first emphatic point to be made is that equations *per se* are not nearly as important as knowing and understanding the chemistry of each reaction. The fact that mere chemical equations are not important is a good seed to sow at this moment. You'll recall that from year to year student "grapevine" defines chemistry as the equation course. "Just know the equations and you'll get a 'C' " is the pass word of the alumni. Continued emphasis is placed upon the memorization of the various *word equations* as the year progresses. These word equations to be memorized are taken up as the course proceeds to the study of oxygen, hydrogen, etc. Naturally, it becomes the instructor's obligation to accurately and carefully point out very soon in the course the meaning of such terms as metal, non-metal, acid anhydride, basic anhydride, and simple means of recognizing acids, bases and salts upon sight of their respective formulae.

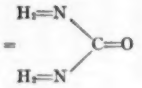
But, our fun certainly does not stop here. Reference is continually made to the basic reaction types. The artist freshens up the wall chart with a picture of a young lady baking a cake to represent Composition. That's right. All of the various ingredients go together to form something—a pie or cake. Decomposition is illustrated by the "ball and chain" being snapped between that couple going "steady" and Single Substitution is likened to a stag cutting in on that dancing couple during one of the school dances. How simple and unforgettable too Double Substitution becomes when two dancing couples exchange their partners for the next dance. Yes, these are the *basic* chemical reaction types and they're learned between student chuckles and smiles as the instructor proceeds from one to another. But, let's not forget their being likened to basic football formations—after all,

football is important, you know. Those many "plays" to follow will certainly fail if a "single-wing" or a "T" of chemistry is forgotten.

The fact that when students first receive the chart, they possess little understanding of valence, formula writing, equation writing and the theory of equations becomes a distinct psychological advantage. There is little to cloud the mind of the learner when intensive stress is laid upon such words as Basic Chemical Reaction types and the word equations listed under Chemistry of the Reaction. The student's mind may be barren of much chemistry, but the fertility is excellent for early sowing of the idea that equations (puzzling as they may appear at this time) are really nothing more than statements of laboratory facts. Know these facts. Commit to memory the *word* equations as studied because they represent laboratory facts. Stress and continue to stress the Chemistry of the Reaction. Assure the learner that soon when chemical symbols, valence, equation writing and equation balancing enter the course of study they merely have to translate these laboratory facts into the chemist's streamlined shorthand. That's right, this method assures the teacher of a healthy approach to equation writing and that "bothersome" valence. Immediately, most students conclude for themselves that writing chemical equations are merely a means to an end. Knowing the Chemistry of the Reaction is the real end in itself. What chemistry instructor shouldn't breathe a pedagogical sigh of relief upon the realization that most of his students are already surveying the course in this mature manner? How many students we have all sent on to advanced courses in chemistry with the false notion that mere equation memorization was the key to success in chemistry? How many times these instructors of advanced courses must have thought that perhaps it would have been just as well if no elementary chemistry courses would have been given the student? For re-education is psychologically much more difficult than initial learning.

During the early use of the chart, it might well be pointed out that one "grows" into the thorough and appreciative use of the plan. Yet, like on any journey, it's always wise to have the entire map before us to gain perspective of the complete trip. Each succeeding day brings us closer to the completion of *our* "chemical trip." Soon students are checking the word equations listed under the Chemistry of the Reaction as laboratory facts to be learned. Soon, too, valence, formula writing and equations are introduced. And, as the teacher enlarges the horizons of what acids, bases, and salts really are, the true value of the chart becomes apparent to the student. Here again the folly of memorizing the Type Equation illustrated on the chart can be shown. The type Equations shown should not be memorized. After all only

IRVING'S SUMMARY OF FUNDAMENTAL INORGANIC CHEMICAL REACTIONS

Type of Chemical Equation	*Chemistry of the Reaction*	*Typical Equations*
Composition	Most Metals or Non-metals + Oxygen = Oxide	$2Cu + O_2 = 2CuO$ ($S + O_2 = SO_2$)
	Metallic oxide (soluble) + Water = Base	$CaO + H_2O = Ca(OH)_2$
	Non-metallic oxide + Water = Acid	$CO_2 + H_2O = H_2CO_3$
	Most Active Metals + Non-metals = Salt	$2Na + Cl_2 = 2NaCl$
	Non-metal + Non-metal (Catalyst) = Gaseous Substance	$N_2 + 3H_2 = 2NH_3$
Decomposition	Oxides or Salts + Reducing Agents = Metal + Water	$CuO + H_2 = Cu + H_2O$
	Water, Acids, Bases, Salts + Electrical Current = Individual Elements	$2H_2O = 2H_2 + O_2$
	Carbonates + Acids = Salt + H_2O + CO_2	$CaCO_3 + 2HCl = CaCl_2 + H_2O + CO_2$
	Carbonates + Heat = Oxide + CO_2	$CaCO_3 + Heat = CaO + CO_2$
	Some Salts (Oxides) + Heat = Decompose	$2HgO + Heat = 2Hg + O_2$ (Also: $2KClO_3 = 2KCl + 3O_2$)
	Hydrocarbon + Active Halogen = Halogen Acid + C	$C_{16}H_{16} + 8Cl_2 = 16HCl + 10C$
Single Substitution	Metal (more active, E.M.F. Series, than metal in reacting salt) + Salt = Metal + Salt	$Zn + Pb(C_2H_3O_2)_2 = Pb + Zn(C_2H_3O_2)_2$
	Non-metal (active) + Salt (containing less active Non-metal) = New Salt + Non-metal	$2NaI + Cl_2 = 2NaCl + I_2$
	Metal (above Hydrogen in E.M.F. Series) + Acid (except CON H_2SO_4 or HNO_3) = Salt + H_2	$Zn + H_2SO_4 = ZnSO_4 + H_2$
	Metal + Base = Salt + H_2	$Zn + 2NaOH = Na_2ZnO_2 + H_2$
	Active Metal + Water = Base + H_2	$2Na + 2H_2O = 2NaOH + H_2$
Double Substitution	Acid + Base = Salt + Water	$HCl + NaOH = NaCl + H_2O$
	Soluble Metallic Oxide + Acid = Salt + Water	$CaO + 2HCl = CaCl_2 + H_2O$
	Non-metallic oxide + Base = Salt + Water	$SO_2 + 2NaOH = Na_2SO_3 + H_2O$
	Acid + Salt = New Acid + New Salt	$H_2SO_4 + 2NaCl = Na_2SO_4(NaHSO_4) + 2HCl$
	Base + Salt = New Base + New Salt	$Ca(OH)_2 + Na_2CO_3 = CaCO_3 + 2NaOH$
	Halide + Oxidizing Agent = Salt + H_2O + Halogen	$4HCl + MnO_2 = MnCl_2 + 2H_2O + Cl_2$
	Halide + Acid + Oxidizing Agent = New Salt + New Salt + Water + Halogen	$2NaCl + 2H_2SO_4 + MnO_2 = MnSO_4 + Na_2SO_4 + 2H_2O + Cl_2$
	Salt + Salt = New Salt + New Salt	$NaCl + AgNO_3 = AgCl + NaNO_3$
Internal Mol. Rearrangement	Ammonium cyanate + Heat = Molecular Rearrangement	$H_2N-\underset{H}{\overset{H}{N}}-C\equiv N=O + Heat =$ 

Simplified Equations Summary of Important Commercial Reactions

Haber Process

$N_2 + 3H_2 = 2NH_3$

Ostwald Process

$NH_3 + 2O_2 = HNO_3 + H_2O$

Contact Process

$S + O_2 = SO_2$
$2SO_2 + O_2$ (Catalyst) $= 2SO_3$
$SO_3 + $ Dil $H_2SO_4 = H_2S_2O_7$
$H_2S_2O_7 + H_2O = 2H_2SO_4$

Hall Process

$2Al_2O_3 + $ Electric Current $= 4Al + 3O_2$

Goldschmidt Process

$2Al + Fe_2O_3 = Al_2O_3 + 2Fe + 207{,}000$ cal.

Solvay Process

$CaCO_3 = CaO + CO_2$
$CaO + H_2O = Ca(OH)_2$
$Ca(OH)_2 + 2NH_4Cl = CaCl_2 + 2NH_3 + 2H_2O$
$NH_3 + H_2O + NaCl + CO_2 = NaHCO_3 + NH_4Cl$
$2NaHCO_3 + Heat = Na_2CO_3 + H_2O + CO_2$

Birkeland-Eyde Process

$N_2 + O_2$ (Electric Arc) $= 2NO$
$2NO + O_2 = 2NO_2$
$2NO_2 + H_2O = HNO_3 + HNO_2$
$HNO_2 + NO_2 = HNO_3 + NO$

CHART From: *The Science of Chemistry*

Copyright by James R. Irving

one is shown in each instance, and it is but representative of many others. For the sake of conformity and textbook reference, orthodox Type Equations are used.

To facilitate the use of the chart among beginning students of chemistry, exceptions to the general pattern of most chemical reactions are not shown. Like any technique employed to simplify and organize a great amount of detail into a teachable and simple approach, exceptions are sure to be recognized. The instructor may wish to insinuate the infallibility of any man-made instrument or approach. After all, this too is a science lesson to be learned. Only the uninitiated and inexperienced attempt the folly of uttering such statements as "in all cases" or this "never" occurs or this "always" happens. But, this Summary of the Fundamental Reactions of Inorganic Chemistry is for the *beginning* student. The foundation of any course must be firmly set before too many exceptions are introduced. In most instances, the chart tells the truth—certainly as much of the truth as a beginning student can hope to comprehend. On the whole, the chemistry of the various reactions illustrated represents the total amount of actual knowledge of reactions the student need know and understand for the preliminary course in Inorganic Chemistry.

The fifth basic type of Chemical Reaction, Internal Molecular Rearrangement, is included for the sake of completion only. It may well be introduced when the average inorganic course touches upon elementary organic chemistry. It need not be emphasized when the initial Basic Reaction Types are first presented.

Stated earlier, the chart is used continually throughout the course from the introduction of basic reaction types. The student grows into its full meaning as the course progresses. The instructor continually refers to the various Chemistry of the Reaction word equations as the spring-board of chemical equation writing. And, actual chemical equations soon find their proper place in the learner's mind as a means to an end. Chemistry isn't a course of equations *per se* at all. Review of the chart is continually stressed throughout daily classroom discussions. An intensive review of the chart is planned after the conventional chapters on Acids, Bases, and Salts. Soon important commercial reactions are summarized by the equations for them found on the chart. The artist has shown these various important commercial reactions in flow-sheet[1] form on the wall size classroom chart aiding the pre-engineering student and chemistry major to familiarize themselves with this method of study.

The pedagogical value of the chart may be summed up as follows:

1. Early in the course of study, the student's attention is turned from mere

[1] *Chemical Engineering Flow Sheets.* McGraw-Hill Publishing Company, New York, N. Y. 3rd Ed. 1940.

memorization of specific equations to an understanding of the *basic* chemistry involved.
2. The Chart provides a good plan of organization. Vicariously, the learner appreciates the value of organization and its significance in learning.
3. The approach to the basic chemistry of reactions and other numerous and important details of the course is greatly simplified.
4. The chart is a *definite* technique of teaching. It provides the learner with something concrete to be achieved.
5. The chart provides a handy correlation device for the instructor. It might well become a thread of continuity for the entire course in elementary inorganic chemistry.

Certainly, the teaching of fundamental inorganic chemical reactions can be fun. But, best of all, experience has shown that all the fun and enjoyment isn't one-sided. Teaching this approach is enjoyable and self-satisfying for the instructor as well.

THE QUIZ SECTION

JULIUS SUMNER MILLER
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1. Two bubbles of the same radius are blown on one end of each of two open tubes. What happens when the tubes are connected at their free ends? What would happen if the bubbles were not of the same radius?
2. Particles are simultaneously projected in ALL directions with velocity V ft/sec from a stationary balloon. Prove that in t seconds all the particles will be situated on a sphere. Find its center and radius.
3. A watch is laid on its back on a smooth table. For simplicity suppose the balance wheel has its axis through the center of gravity of the rest of the watch. Will the watch gain or lose time?
4. In going over an arched bridge what maximum speed is possible for the wheels to keep contact with the road?
5. The cushion of a billiard table is at a height above the table equal to 7/10 of the diameter of a billiard ball. Explain.
6. Given a solid and a hollow sphere of the same size and mass. How would you distinguish them?
7. If the fingers are immersed for a long time in a strong soap solution the skin becomes crinkled and loose. Explain.

AMERICAN SCIENTIST HONORED AS MEMBER OF ITALIAN ACADEMY

Dr. Harlow Shapley, director of the Harvard College Observatory and president of Science Service, has been elected honorary foreign member of the Italian Academy of the Lynxes, oldest national academy in the world.

Another astronomer member of the academy was Galileo Galilei, elected to membership in 1611, eight years after the founding of the Academy. Dr. Shapley is the third American member. Others are Dr. Ross Harrison of Yale University and Dr. Arthur H. Compton, chancellor of Washington University, St. Louis.

Prof. Guydo Castelnuovo, president of the academy, has notified Dr. Shapley that he has been assigned to the class of physical, mathematical and natural sciences.

The animal-name of the Italian science group was derived from the aim of the founders to examine all subjects with "lynx-eyed keenness." Three centuries ago, the lynx, of which the American bobcat is one species, was believed to be able to see through stone walls.

NOTES FROM A MATHEMATICS CLASSROOM

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145. Book Four Is Neglected. Textbooks are getting larger and larger because more and more material of a simple character is being introduced for the benefit of the slow learners. The larger the book becomes, the greater is the probability that the second half of it—or at least the last third—will be neglected. It is a popular impression that Books Four and Five of geometry deal only with some theorems about areas, and that these can be treated briefly or even omitted since the pupil learned in eighth grade how to find areas of rectangles, triangles, and circles. Hence let us consider some of the places in Book Four where we can do more than arithmetic computations.

Consider the theorem about the area of a parallelogram. Perpendiculars are drawn from the ends of the upper base, two right triangles are proved congruent, and they in turn are added to a certain trapezoid. But the proof fails if the left end of the upper base is at the right of the righthand end of the lower base. Hence I assign as an extra credit the job of finding a better proof, mentioning that a truly good proof should be applicable to *all* figures and not need supplementary proofs for peculiar figures. The solution is of course very simple. Instead of *adding* certain triangles in turn to the inner trapezoid, we should *subtract* them from the larger trapezoid which is always in the figure.

The theorem "A median of a triangle divides the triangle into two equal parts" is the foundation stone for all work dealing with the center of gravity of a polygon. The concept of center of gravity is worth half an hour in any geometry class because of its importance to prospective engineers and its use in the physics class. We can also discuss how the center of gravity of any quadrilateral is found, and occasionally a bright pupil will derive the formulas for the location of the center of gravity of an isosceles trapezoid. This is an unusually good problem for mathematics clubs.

A very interesting half hour can be had by drawing the three medians of a triangle, asking how many triangles and quadrilaterals there are in the drawing, and how many pairs of equal triangles and equal quadrilaterals can be found. The fact that much can be said about a simple figure and that many of the conclusions are easily proved has a great appeal to the dull pupils in the class. In fact, the duller the class, the more time I spend on this exercise. And I follow it with the problem: In how many different ways can a parallelogram be divided into four equal parts? This may sound like scissor work for a kindergarten class but it revives interest.

The area of a rhombus equals half the product of the diagonals. This exercise is worth consideration, not because of the relation involved but because of the many different ways in which the pupils get the result and what can be learned therefrom. Some pupils find the area of one of the triangles and multiply by four; others find the area of one of the larger triangles and double it; some pupils laboriously add when they might multiply. Further, when finding 4 times the expression $\frac{1}{2} \times AE \times FD$ some pupils take 4 times each of the factors, thus giving the teacher a good excuse for reviewing and reteaching the correct rule for such cases.

One of the most difficult theorems to teach is "Areas of similar polygons are proportional to the squares of corresponding sides." The difficulty may lie in the fact that the statement seems to contradict our experience, or the pupil's lack of experience in comparing areas. As a starter I have put this problem to the class:

The fence around one baseball field in the form of a square is just twice as long as the fence around another square baseball field. Is the larger field 2, $2\frac{1}{2}$, 3, $3\frac{1}{2}$, 4, or 5 times as large as the smaller?

The answer is seldom correct. As a further introduction to the theorem we divide squares into smaller squares, join the midpoints of sides of a triangle, triple the sides of a traingle, and so forth. But when I give a test on this nuit, I get poor results on the problem:

The sides of a triangle are 3, 4, and 5. Similar polygons are constructed on the sides. The area of the smallest polygon is 15. What is the area of the largest polygon?

I wish the textbooks on pedagogy would explain some good ways to teach that theorem. My own analysis of the poor results is that the pupil will not take the trouble to write carefully the data in the problem. If I can force him to write $A = 15, a/a' = 5/3, A' = ?$ then he has a better chance of success.

Another neglected theorem is "If similar polygons are constructed on the three sides of a right triangle, the polygon on the hypotenuse equals the sum of the other two." The theorem is useful because it generalizes the Pythagorean theorem, and I have a great inclinationn to grasp a chance to discuss generalizations.

At the end of Book Four there are many construction problems whose solutions illustrate the analytic method, such as transforming a rectangle into another with a specified base. I do as many of these as time permits, but the work is not so important nor so interesting as the other items I have mentioned.

146. The Fallacy of Special Cases. Optical illusions are often used in beginning geometry to show the need for a proof based on something else than appearances. Teachers also use that famous quantity n^2+n+41, which is prime for all integral n less than 41, to

show that a number of examples will not by themselves constitute a proof. In a geometry class a geometric example would have more conviction.

The triangle whose sides are 6, 8, and 10 has 24 for its perimeter and 24 for its area. If the sides are 5, 12, and 13, the perimeter equals the area, numerically. There are an infinite number of triangles (right, and otherwise) for which the relation holds. For any triangle there exists a similar triangle whose perimeter equals its area. If the sides are a, b, and c, then the triangle whose sides are ka, kb, and kc will have its area and its perimeter equal if k is chosen equal to $(a+b+c)$ divided by the area of the original triangle.

This example may be useful in pointing out the difference between experimental and demonstrative geometry. But when starting a geometry class I prefer to emphasize that we are not interested in whether a statement is true or false; we want to know what *causes* a statement to be true or false.

Incidentally, note that the above multiplier, k, is the reciprocal of the diameter of the inscribed circle. A question that I had difficulty in answering was once asked by a pupil: "How can the diameter of the inscribed circle have anything to do with causing a triangle to shrink in such a way that its area becomes equal to its perimeter?"

147. When To Begin Signed Numbers. The chapter that teaches the four operations with signed numbers seems to be getting farther and farther from page 1. Examining some books we find that this work begins on page 55, 82, 107, 131, 143, and 154. The preceding pages involve graphs, formulas, and equations. The texts that begin signed numbers late are evidently intended to be used both for classes in algebra and classes in general mathematics. The latter must of course have material that looks like algebra but is essentially arithmetic and, above everything, material that is simple enough for those who supposedly cannot learn algebra.

The presence of such material in a text is not conducive to a good course in algebra. The teacher must have a strong mind to be able to resist the temptations offered by work on areas, volumes, percentages, dozens of kinds of graphs, using, making, and finding formulas. This material looks more important and decidedly more practical than factoring a^2-b^2. It is. But it is a waste of time to treat these topics first with only positive numbers, and then to do the work again with both positive and negative numbers. The topics at the end of the text would be less neglected if some of the unnecessary duplications were eliminated.

To provide for those pupils who enter a week or two late and for other school emergencies, it is wise to spend the first two weeks of September with miscellaneous odds and ends of formulas, simple

equations, algebraic symbols, and so forth. Learning how to use signed numbers might well begin on Monday of the third week of school.

Much time could also be saved if the introduction to signed numbers were simplified. If a boy earns $8 one week but loses a ten dollar bill from his pocket, how much better or worse off is he? If a merchant makes a profit of $3 on one sale and a loss of $5 on another sale, what is the total profit? Not much more than those two sentences are needed to introduce signed numbers. But the textbooks present illustration after illustration after illustration—in fact, almost every application of signed numbers that any writer has ever discovered through all history. The fault is with the authors; they are obsessed with putting *meaning* into the concept. Or else they cannot decide which illustration to use and hence use all of them, thus helping to waste time in class. Putting meaning into a concept is desirable, but it should be added a little at a time as a cook adds salt to the soup.

148. Signs of the Trigonometric Functions. Referring to previous notes on this topic, A. W. Elliott, *Metuchen High School, N.J.*, writes: "I have for many years been using the S-A-T-C device mentioned in the October issue. In connection with it I give the class the phrase *A Smart Trigonometry Class*, usually adding the remark that if they don't think these words appropriate, there is another adjective also beginning with S that they can substitute. The phrase is easily remembered."

MATTER AND MOLECULES—

Matter and Molecules, a kit of six discussional slidefilms in The Jam Handy Organization's "Air Age Physics" series, is ready for immediate use by instructors. The first film, "Why Study Physics?" introduces the student to the subject of physics and is intended for use at the beginning of the course. The other films in the kit provide the teacher with visualized material for the study of matter and molecules in high school physics courses. These films are designed to save the teacher's time and, while giving complete presentations, are planned to tie in with reading materials, textbooks, laboratory work, and other special assignments. The material for each film is organized to several lessons with summaries and questions for group discussion at the close of each lesson.

Films in this kit are: 1. Why Study Physics? 2. Matter. 3. Structure of Matter. 4. Effects of Molecular Motion. 5. Molecular Forces in Matter. 6. Molecular Forces in Liquids. For details, write to The Jam Handy Organization, 2821 East Grand Boulevard, Detroit 11, Michigan.

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OLIVER WENDELL HOLMES

THE EDUCATIONAL EXTENSION PROGRAM OF THE ILLINOIS STATE GEOLOGICAL SURVEY

GILBERT O. RAASCH
Associate Geologist in Charge of Educational Extension

The overall objective of the Educational Extension Program of the Illinois State Geological Survey is to bridge the gap between the geologist and the general public, and to make the fruits of the science available to the layman according to his particular needs and desires. Geology may be approached through the layman's wish to understand and to interpret a little more of the things of nature—to expand his horizon. Or he may come to the science through a need for assistance in solving some economic problem. Or he may be drawn to look more deeply into geology through a civic-minded interest in, or concern with public questions, such as mineral conservation or mineral stockpiling.

Educational Extension in geology has a two fold purpose. There is the more immediate one of contributing to the particular individual's intellectual pleasure or material need. But even more fundamental in a democracy, where every voter is a policy-maker, is the necessity for the average citizen to be fully aware of the basic role that mineral resources and their proper utilization play in our social and economic system and in our position as a world power. The local corollary to this broader concept is the defining of the position that the particular state plays in relation to the national and international mineral picture, and, in the present instance, the part that the State Geological Survey plays in its relation to Illinois' mineral industry.

PROGRAM

The Educational Extension Division of the Illinois State Geological Survey contacts the public through a number of channels, including non-technical publications, collections of geological material, lectures, exhibits, public field trips, correspondence involving identification and information, and through the press. Closely dovetailed with this general program, is one especially designed to assist the teachers of the State in the geological science.

To carry out this program, the Survey at present employs two full-time and two part-time employees, supported of course, by the staff and facilities of the Survey as a whole.

EDUCATIONAL PUBLICATIONS

Although most of the Survey's publications are of a technical character, many of the bulletins dealing with the areal and economic geology of specific districts include sufficient general material on

fundamental concepts to be adaptable to the lay reader, particularly to the high school teacher. As an example, J Harlen Bretz's "Geology of the Chicago Region" may be cited. In addition, there has been set up a separate series of educational bulletins, abundantly illustrated and simply written. To date, three of these have been issued and one, entitled, "Typical Rocks and Minerals in Illinois," has been reprinted a number of times. Furthermore, among the Survey's "Circulars" are pamphlets characterized by an extremely simple style and designed primarily to be broadcast at public fairs and among primary school children. Others in this series are in essence reports of progress to the general public. An example of the first is Circular 124, "What About Our Minerals?" and of the second, Circular 126, "Operation of the Illinois State Geological Survey." The series of popular publications on geology is augmented from time to time as a result of the cooperative efforts of other State organizations. For example, a small pamphlet, "The New Oil Fields of Southern Illinois," was written and illustrated by the Survey, published by the State Chamber of Commerce, and distributed by both organizations. A spontaneous demand from the public for popular publications continues to come at an accelerated rate. The Survey receives numerous requests for publications on the physiography and on the general geology of the State, for handbooks to assist mineral and fossil collectors, for field trip guidebooks, and for material on mineral conservation. It is attempting to satisfy this demand for such publications to the extent that staff and time permit.

Service to the Schools

Many a life interest has been awakened in high school. The selection of courses by college freshmen may be a hit-or-miss affair or it may be guided, in part at least, by an early interest in some subject to which the student has already been happily introduced. Unfortunately, geology has not been widely taught in our high schools. Accordingly, the study of geology is neglected by many, for whom it remains one of those semi-popular, semi-mysterious things it "would be nice to know more about." We believe that the educational objectives of us all can be benefited by stimulating an interest in fundamental subjects like geology among the teachers of our secondary schools. The arousing and fostering of this interest in the teaching of geology is a major objective of the Educational Extension Program of the Survey.

Rock and Mineral Study Sets

One important phase of this program is the preparation of sets of rocks, minerals, and fossils typical of Illinois. All the sets are supplied with printed labels giving the most essential information about each

item. These sets are not loaned, but given to schools and other organizations for only the cost of mailing charges. The response to the service has been most gratifying. In the past year, for example, more than 650 sets of 35 specimens each have been distributed to schools, scout troops, nature clubs, and other organizations. Many cordial letters of appreciation have been received from teachers and pupils.

Field Trips for Teachers

To contact high school science teachers more directly the Survey annually conducts a series of six field trips. These trips are carefully scouted, and mimeographed itineraries are prepared in advance. The localities are chosen in such a manner that no section of the State is remote from a field trip center; selection is made, not so much on a basis of the most spectacular points of interest, but rather for the purpose of illustrating that geology is universal and accessible to every high school teacher, regardless of the geographical location of the school. In early fall, advance publicity is sent to each high school, as well as to all persons having previously indicated an interest in the trips. Itineraries and maps are distributed at the beginning of the trip, which is generally confined to a period of about six hours, to a minimum number of stops, and to a limited geographic area. No fee is charged, as participants supply their own picnic lunches and transportation.

Exhibits

An effective means of contacting wide sections of the general public is through exhibits. Last year the Survey prepared displays in connection with the meeting of the Geological Society of America in Chicago and participated in the Old King Coal Cavalcade, at West Frankfort, in the heart of the Southern Illinois coal district. For the past two summer seasons, an attractive exhibit highlighting the applied research activities of the Survey has been presented at the State Fair and at numbers of county fairs. These procedures have proved an excellent means of contacting the general public over a wide area, and thereby appreciably furthering our Educational Extension Program.

Public Lectures

Each year the staff of the Survey gives a limited number of lectures to schools, Rotary Clubs, and other civic groups, and also is called upon to assist in special summer courses in conservation for school teachers. It is a conscious policy of the Survey not to solicit lecturing opportunities, but merely to respond to spontaneous requests to the extent that it is able. In this way, geology may be popularized without the public's coming to feel that we have something we are trying to

sell or propagandize. The Survey's policy on radio broadcasting follows the same line as that relative to personal lecture appearances.

Press Publicity

The Educational Extension Division channels the news releases issued by the Survey, and prepares many of them. News releases fall into several categories: stories for local papers in the Champaign-Urbana area, stories for state-wide release through publicity channels of the State administration, special stories for large newspapers, and articles for trade journals and periodicals. Because of the nature of the material, and of the difficulty newspapers have in maintaining scientific accuracy, very little news is issued directly to interviewers or reporters; almost all stories go out as written releases issued and checked by the Survey.

Photography

A program for securing high-quality photographs illustrating the geology, the mineral resources, and the operations of the Survey in Illinois is being carried on under the direction of the Educational Extension Division. Such a photographic library is extremely useful for purposes of press publicity, for illustrating the more popular publications of the Survey, for exhibits, and for the preparation of lantern slides. In addition the Survey has prepared one motion picture film on the oil industry. Under the existing setup, the Survey does not deem it expedient to institute a lantern slide or motion picture loan service inasmuch as this would require a very considerable addition of clerical and photographic personnel.

Summary Statement

The Educational Extension policy of the Survey is oriented toward meeting popular demand for information on natural science, including the desire of public school teachers to create a more enlightened citizenship. It is, in fact, merely attempting to meet the public half way in their constantly rising demand for geological popularization.

VOLCANO'S WATER VAPOR

The famous lava is not the only product emitted from the crater of a volcano. Mexico's Paricutin has given off an estimated 16,000 tons of water vapor in one day.

This vapor from the crater was probably from ground water, explains W. F. Foshag of the U. S. National Museum, Washington, D. C. He suggests that rock alterations in many ore deposits may be due to such activation of ground water.

SCIENCE LEGISLATION
NATIONAL SCIENCE FOUNDATION BILLS

I. A Brief History

Compiled by
Eleanor Johnson, *Librarian*
Purdue University, Physics Department

"Nov. 1944.

President Roosevelt addressed four questions to Vannevar Bush relating to: (a) making wartime developments in science known to the world, (b) continuing the war of science against disease, (c) federal aid for research activities in public and private organizations, and (d) the discovery and development of scientific talent.

July 1945.

Having received the reports of four separate committees, each appointed to study one of the questions, Dr. Bush replied to the President with his now famous report entitled 'Science, the Endless Frontier' " *Science*, vol. 104, Dec. 27, 1946, p. 615.

"Summary of the report to the President on a program for postwar scientific research" by Vannevar Bush, Director of OSRD. *Science*, v. 102, July 27, 1945, p. 79.

"The effective discharge of these new responsibilities will require the full attention of some over-all agency devoted to that purpose. There is not now in the permanent Governmental structure receiving its funds from Congress an agency adapted to supplementing the support of basic research in the colleges, universities, and research institutes, both in medicine and the natural sciences, adapted to supporting research on new weapons for both Services, or adapted to administering a program of science scholarships.

Therefore, I recommend that a new agency for these purposes be established. Such an agency should be composed of persons of broad interest and experience, having an understanding of the peculiarities of scientific research and education. It should have stability of funds so that long-range programs may be undertaken. It should recognize that freedom of inquiry must be preserved and should leave internal control of policy, personnel and the method and scope of research to the institutions in which it is carried on. It should be fully responsible to the President and through him to the Congress for its program."

"Senator Warren Magnuson, of Washington, introduced into the Senate a bill (S. 1285) embodying the principal recommendations of the Bush Report; a part-time Board of scientists to administer a program for the support of basic research in the natural sciences, including medicine, and for the grant of scholarships and fellowships.

Senator Harley Kilgore offered a rival bill (S. 1297) which agreed in (a) its support for basic research in the natural sciences, and in (b) provisions for scholarships and fellowships, but disagreed in its provisions for (c) a single administrator instead of a part-time Board, (d) the coordination of all Federal research, (e) restricting patents on discoveries made with government funds, and (f) the inclusion of the social sciences." *Science*, vol. 104, Dec. 27, 1946, p. 615.

September 1945.

President's message to Congress, Sept. 6, 1945, in which he endorsed the basic policies of the Kilgore Bill.

Science, vol. 102, Oct. 5, 1945, p. 346–347.

"In his message to Congress, Pres. Truman specifically called for a single Federal research agency which would perform the following functions.

1. Promote and support fundamental research and development projects in all matters pertaining to the defense and security of the Nation.
2. Promote and support research in the basic sciences and in the social sciences.
3. Promote and support research in medicine, public health and allied fields.

4. Provide financial assistance in the form of scholarships and grants for young men and women of proved scientific ability.
5. Coordinate and control diverse scientific activities now conducted by the several departments and agencies of the Federal government.
6. Make fully, freely and publicly available to commerce, industry, and agriculture and academic institutions, the fruits of research financed by Federal Funds."

October–November 1945.

Hearings held before a Subcommittee of the Senate Committee on Military Affairs showed 99 percent of the witnesses were in favor of a Science Foundation.

November 1945.

Dr. Isaiah Bowman wrote to President Truman in behalf of the "Committee Supporting the Bush Report."

December 1945.

"President Truman replied to Dr. Bowman, reaffirming his views as expressed to Congress in September.

On the basis of the testimony, a revised bill, S. 1720, was introduced by Senator Kilgore and others. The Board was strengthened, the patent phraseology was modified, the social sciences were still included, and provisions for a register of scientific and technical personnel and for international cooperation were added.

Under the leadership of H. C. Urey and Harlow Shapley, a "Committee for a National Science Foundation" was formed and issued a statement generally endorsing S. 1720, though not naming it specifically.

January 1946.

Senators Thomas, Kilgore, and Magnuson discussed controversial issues with Drs. Bush and Bowman in an effort to revise S. 1720 so that it would be acceptable to all concerned." *Science*, vol. 104, Dec. 27, 1946, p. 615.

February 1946.

Compromise bill S. 1850 was introduced on Feb. 21, 1946.

March 1946.

S. 1850 was favorably reported out of the Military Affairs Committee.

April 1946.

"The Committee Supporting the Bush Report endorsed S. 1850 in a letter to the President and the Congress.

The Council of the AAAS endorsed S. 1850 by a vote 230–10.

The National Association of Manufacturers announced its opposition to S. 1850." Ibid.

May 1946.

"Rep. Wilbur B. Mills introduced H. R. 6448, a bill to establish a Science Foundation long the lines of the original Magnuson Bill. This bill was referred to the Subcommittee on Public Health of the Interstate and Foreign Commerce Committee. Hearings were arranged without inviting or notifying representatives of the Committee for a National Science Foundation, or the AAAS. Among those who learned of the hearings and testified in favor of the Mills Bill were representatives of the National Association of Manufacturers, the Committee Supporting the Bush Report, and Dr. Bush." Ibid.

June 1946.

Dr. James Conant, and a group of outstanding scientists, published statement endorsing S. 1850.

July 1946.

"With its social science provisions stricken from it, S. 1850 pased the Senate by a vote of 48–18 and was referred to the House. It died in the Interstate and Foreign Commerce Committee." Ibid.

January 1947. 80th Congress.

Representative Celler introduced H. R. 942 (identical with former S. 1850).

February 1947.

"Two bills providing a National Science Foundation were introduced into the Senate, Feb. 7. The first bill, now numbered S. 525, was introduced by Senator Elbert D. Thomas of Utah and is identical with the S. 1850, which passed the Senate in the 79th Congress. The new bill S. 526, introduced by Senator H. Alexander Smith, is a compromise measure." It "provides for the creation of a National Science Foundation composed of 48 'outstanding' men and women who are leaders in the fields of the fundamental sciences, medical sciences, engineering, education, or public affairs, to be appointed by the President. This body is authorized to develop and encourage scientific research in the interest of national welfare and defense, including the award of scholarships and fellowships and global interchange of scientific information. The 48 members would delegate broad powers to an executive committee of 9 members, who would select the Director and Deputy Director of the Foundation. It provides for the immediate establishment of 5 divisions: medical research, physical sciences, biological sciences, national defense, and scientific personnel and education. The inclusion of the social sciences is left to the judgment of the Foundation." *Science*, vol. 105, Feb. 14, 1947, p. 171.

Simultaneously on February 10, Representatives Case, Mills and Priest introduced into the House bills now numbered H. R. 1815, 1830, and 1834. These three bills are identical to the Smith measure in the Senate, S. 526.

On February 23, representatives from nearly a hundred scientific societies met in Washington, and formed the Inter-Society Committee for a National Science Foundation. They elected Edmund Day of Cornell University, chairman and Harlow Shapley, vice-chairman. This group was sponsored by the AAAS with the purpose of getting a National Science Foundation bill enacted.

March 1947.

Hearings on House bills H. R. 942 (S. 525) and H. R. 1815, 1830, 1834 (S. 526) were held on Mar. 6–7. A score of witnesses testified, several including James B. Conant of Harvard and Vannevar Bush who testified in favor of the bills H. R. 1815, 1830, 1834 (S. 526), whereas others, particularly those representing the Administration, seemed to favor the Celler Bill, H. R. 924.

A Survey made by the Inter-Society Committee revealed that two-thirds of the group preferred a Foundation with a single administrator, with about 18 percent favoring the commission type. 98 percent favored the inclusion of the social sciences, 86 percent favored undergraduate scholarships, and 94 percent believed no special stand should be taken on the patent question.

April 1947.

Senate Committee on Labor and Public Welfare reported favorably on National Science Foundation bill S. 526, with amendments as affecting a compromise between S. 525 and S. 526. Major amendments provide (1) foundation shall consist of 24 members, (2) terms of office shall be staggered, (3) committee for the Division of National Defense shall consist of not less than 12, nor more than 36 members, half of whom shall be civilians appointed by the Foundation, (4) there shall be an executive committee of not more than 6 members in the Division of National Defense, (5) and this Committee shall advise on matters of security classification, (6) no officer or employee to secure patent rights to inventions produced in connection to assigned activity, (7) grants for research be given to lesser institutions which show potentiality for advancing research as well as the larger ones, (8) funds now available for government projects be transferred to Foundation upon approval of agency concerned, (9) the National Roster be transferred to the Foundation. *Science*, vol. 105, April 18, 1947, p. 407.

May 1947.

Senate passed the National Science Foundation Bill on May 20, 1947. The

final vote was 79–8. Two major amendments were added (1) 25 percent of funds be distributed to tax supported and land-grant colleges. (2) Director will be appointed by the President of the United States instead of the Executive Committee of the Foundation.

July 1947.

H. R. 4102 (essentially the same as S. 526) was introduced into the House by Representative Wolverton of New Jersey. It, however, stipulates that the director be appointed by the Foundation of 24 members, and omits social science and allotment of funds to states. Bill passed the House. Conferees from the House and Senate met in order to reach a compromise on issues of appointment of Director, allotment of funds, and patent provisions. Agreement reached in favor of the House bill. House and Senate quickly passed it and sent it to the President.

August 1947.

"The National Science Foundation bill, was vetoed by President Truman on Aug. 6. The President, at the same time, urged that Congress reconsider and pass an acceptable bill when it reconvenes. The veto message stated that the bill implied 'a distinct lack of faith in the democratic process' and, in effect, would 'Vest the determination of vital national policies, the expenditure of large public funds, and the administration of important governmental functions in a group of individuals who would be essentially private citizens.' It went on to say that 'Full governmental authority and responsibility would be placed in 24 part-time officers whom the President could not effectively hold responsible for proper administration." *Science*, vol. 106, Aug. 15, 1947, p. 141.

(*To be continued*)

PROBLEM DEPARTMENT

CONDUCTED BY G. H. JAMISON
State Teachers College, Kirksville, Mo.

This department aims to provide problems of varying degrees of difficulty which will interest anyone engaged in the study of mathematics.

All readers are invited to propose problems and to solve problems here proposed. Drawings to illustrate the problems should be well done in India ink. Problems and solutions will be credited to their authors. Each solution, or proposed problem, sent to the Editor should have the author's name introducing the problem or solution *as on the following pages.*

The editor of the department desires to serve its readers by making it interesting and helpful to them. Address suggestions and problems to G. H. Jamison, State Teachers College, Kirksville, Missouri.

SOLUTIONS AND PROBLEMS

Note. Persons sending in solutions and submitting problems for solutions should observe the following instructions.

1. Drawings in India ink should be on a separate page from the solution.

2. Give the solution to the problem which you propose if you have one and also the source and any known references to it.

3. In general when several solutions are correct, the ones submitted in the best form will be used.

Late Solutions

2047, 9, 50, 51. *Alan Wayne, Flushing, L.I., N.Y.*

2047. *Hazel Wilson, Annapolis Md.; Joseph Lerner, Roxbury, Mass.; M. M. Dreiling, Collegeville, Ind.; Belle Nickels, Columbia, S.C.; V. C. Bailey, Evansville, Ind.; Stephen Ball, Tecumseh, Mich.; William I. Jacobs, Brooklyn; M. Kirk, Philadelphia.*

2049. *Joseph Lerner, Roxbury, Miss.; V. C. Bailey, Evansville, Ind.; Stephen Ball, Tecumseh, Mich.; William I. Jacobs, Brooklyn.*

Solution by Max Beberman, Nome, Alaska

2053. *Proposed by W. R. Warne, Dayton, Ohio*

Solve the system:

$$y^2=xz \tag{1}$$

$$x+y+z=28 \tag{2}$$

$$xyz=512. \tag{3}$$

Solution by Max Beberman, Nome, Alaska

Substituting (1) in (3):

$$y^3=512. \tag{4}$$

$$y=8. \tag{5}$$

Substituting (5) in (1) and (2):

$$xz=64 \tag{6}$$

$$x+z=20. \tag{7}$$

Squaring both sides of (7) and subtracting four times (6):

$$x^2-2xz+z^2=144. \tag{8}$$

Taking the square root of both sides we obtain

$$x-z=\pm 12. \tag{9}$$

Solving (9) and (7) simultaneously we have the two solutions

$$x=16,\ y=8,\ z=4 \quad \text{and} \quad x=4,\ y=8,\ z=16. \tag{10}$$

Note. Three readers, Hugo Brandt, Felix John and the proposer obtain from (4) the values $y=-4(1\pm i\sqrt{3})$. They then obtain corresponding values for x and z.

Others offering solutions are: Mildred Hopkins, Kankakee, Ill.; Gerald Conway, Rochester, Minn.; Hazel Wilson, Annapolis, Md.; M. M. Dreiling, Collegeville, Ind.; R. T. Ashbaugh, Longmont, Colo.; V. C. Bailey, Evansville, Ind.; James Grabild; W. R. Smith, Pass a Grille Beach, Fla.; L. D. Goldsmith, Amboy, Ill.; P. S. Marthakis, Salt Lake City; Joseph Bradley, Slamokin, Penna.; Leonard F. Leamy, Worcester, Mass.; M. I. Chernofsky, Long Beach, N.Y.; Donald Gengler, Krusen, Ia.; May E. Richards, Northbrook, Ill.; L. R. Galebaugh, Lebanon, Penna.; M. Joseph, Milwaukee, Wis.; M. Kirk, Philadelphia.

2054. *Proposed by Hugo Brandt, Chicago*

Find the area of the loop of $y^2(1+x)=x^2(1-x)$.

Solution by V. C. Bailey, Evansville, Indiana

$$\text{Area}=2\int_0^1 y\,dx=2\int_0^1 \frac{x}{1+x}\sqrt{1-x^2}\,dx.$$

Integrate by trigonometric substitution where $x=\sin Z$.

$$\text{Area}=2\int_0^{\pi/2} \sin Z(1-\sin Z)\,dZ$$

$$\text{Area} = 2 - \pi/2.$$

Other solutions were offered by M. M. Dreiling, Collegeville, Ind.; Felix John, Ammendale, Md.; Solomon Popler, Bradley Beach, N.J.; Orville A. George, Mason City, Ia.; Max Beberman, Nome Alaska; Hugo Brandt, Chicago; W. J. Cherry, Berwyn, Ill.

2055. *No solution has been offered.*

2056. *Proposed by William W. Johnson, Cleveland, Ohio.*

Solution by W. J. Cherry, 2123 Oak Park Ave., Berwyn, Ill.

A metal cube, edge 4, has holes with 2 as diameter bored through the center of all its faces. What is the volume of metal remaining in the cube?

Fig. 1 shows an octant of the volume which two circular cylinders intersecting at right angles have in common. A cross section is a square of area x^2. The volume of the common part is found as follows:

$$V = 8\int_0^1 x^2 dy = 8\int_0^1 (r^2 - y^2)dy = 8\left[y - \frac{y^3}{3}\right]_0^1 = \frac{16}{3}.$$

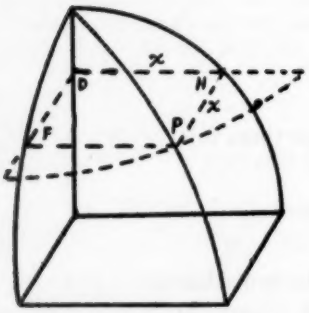

FIG. 1

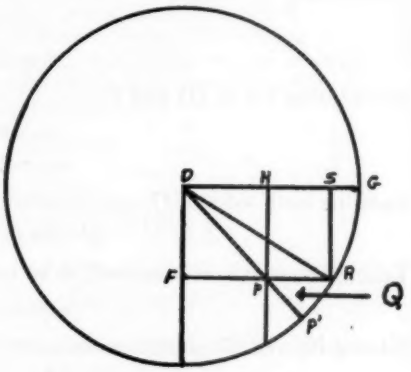

FIG. 2

The volume of metal cut out by the first two bores is:

$$V = 2\pi r^2 h - \frac{16}{3} = 2(3.1416)(1)^2(4) - 5.3333 = 19.7995.$$

The third cylinder will cut out, for a distance of 1 on either side, a volume of metal $= 2\pi = 6.2832$.

To find the volume of the rest of the metal removed, regard fig. 1 as representing an eighth of the space left in the center of the cube when the first two cylinders have passed through. The third cylinder will begin passing entirely through "space" when its circumference reaches P, where DP = the radius of the cylinder. At this moment $x = \frac{\sqrt{2}}{2}$ (from $x^2 + y^2 = r^2$, since $r = 1$), and $y = \frac{\sqrt{2}}{2}$ Fig. 2 gives the view looking down. The problem is to find the volume generated by the area Q between the limits 1 and $\frac{\sqrt{2}}{2}$. This must be multiplied by 16 to account for the whole.

Find the volume generated by the sector DRG:

$$\text{Area} = \tfrac{1}{2}r^2 \text{ arc cos } \frac{y}{r}$$

$$V = \tfrac{1}{2}\int_{\frac{\sqrt{2}}{2}}^{1} \text{arc cos } y\,dy = \tfrac{1}{2}\left[y \text{ arc cos } y - \sqrt{1-y^2}\right]_{\frac{\sqrt{2}}{2}}^{1} = .0759. \qquad (1)$$

Find the volume generated by the triangle DFR:

Area $=\frac{1}{2}xy$

$$V=\tfrac{1}{2}\int_{\frac{\sqrt{2}}{2}}^{1} xy\,dy=-\tfrac{1}{4}\int_{\frac{\sqrt{2}}{2}}^{1}\sqrt{r^2-y^2}\,(-2y\,dy)=-\tfrac{1}{6}(1-y^2)^{3/2}\Big]_{\frac{\sqrt{2}}{2}}^{1}=.0589 \qquad (2)$$

Find the volume generated by the triangle DFP:

Area $=\frac{1}{2}x^2$

$$V=\tfrac{1}{2}\int_{\frac{\sqrt{2}}{2}}^{1} x^2\,dy=\tfrac{1}{2}\int_{\frac{\sqrt{2}}{2}}^{1}(r^2-y^2)\,dy=\tfrac{1}{2}\Big[y-\frac{y^3}{3}\Big]_{\frac{\sqrt{2}}{2}}^{1}=.0387. \qquad (3)$$

Subtract (3) from (2) $=.0202.$ (4)

Add (4) and (1) $=.0961.$ (5)

Find $\frac{1}{8}$ the volume of a cylinder of radius 1 and height $(1-\frac{\sqrt{2}}{2})$.

$$\tfrac{1}{8}V=\tfrac{1}{8}\pi r^2h=\tfrac{1}{8}\pi(1-.707)=.115. \qquad (6)$$

Subtract (5) from (6) $=.0189$ (7). Multiply (7) by $16=.3024$. Add all volumes of metal removed: $.3024+6.2832+19.7995=26.3851$. Volume of cube $=64$. $64-26.3851=37.6149=$vol. of metal left.

Other solutions were offered by Hugo Brandt, Chicago, and Gerald W. Conway, Rochester, Minn.

2057. *Proposed by Walter R. Warne, Dayton, Ohio.*

Solve without the use of the factor theorem and synthetic division

$$x^4-6x^3+12x^2-20x-12=0.$$

First Solution by S. E. Field, Gogebic Junior College, Ironwood, Michigan.

This function is easily factored by grouping into

$$(x^2-4x-2) \quad \text{and} \quad (x^2-2x+6).$$

Equating each of these factors to zero, we obtain the four roots

$$x=2\pm\sqrt{6} \quad \text{and} \quad x=1\pm i\sqrt{5}.$$

Second Solution by Hugo Brandt

By plotting the curve seems to be symmetric to $x=2$. Hence assume that $x=2+a$ and $x=2-a$ are solutions. This gives $x^2-4x+4-a^2$ as one factor of y. Call a^2-4, b. Also let x^2-cx+d be the other factor. Put $y=(x^2-4x+b)(x^2-cx+d)$. Expanding one obtains

$$\begin{aligned} 4+c&=6\\ d+4c-b&=12\\ 4d-bc&=20\\ bd&=12. \end{aligned}$$

These conditions give $c=2$, $d=6$, $b=2$. Hence the factors of y are $(x^2-4x-2)(x^2-2x+6)$.

Solutions were also offered by Orville A. Geoyr, Mason City, Ia.; Felix John, Philadelphia; Mildred Hopkins, Kankakee, Ill.; and the proposer.

2058. *Proposed by Norman Anning, Univ. of Mich.*

Show by skill rather than strength that

$$\begin{vmatrix} a & a+p & a+2p \\ b+2q & b+q & b \\ c & c+r & c+2r \end{vmatrix}=0.$$

Solution by B. Felix John, Ammendale, Md.

From twice the second column subtract the sum of the first and third columns:

$$\begin{vmatrix} a & 0 & a+2p \\ b+2q & 0 & b \\ c & 0 & c+2r \end{vmatrix} = 0.$$

Some other brief solutions are suggested:
By Hazel Wilson, Annapolis, Md.
Subtract the first column from the second and the third.
By M. M. Dreiling, Collegeville, Ind.
Add to column one the sum of column two times -1 and column three.
By Mildred Hopkins, Kankakee, Ill.
Subtract column two from column three and also column one from column two.

Other solutions were given by Robert H. Brooks, Chicago; M. I. Chernofsky, Long Beach, N.Y.; P. S. Marthakis, Salt Lake City; Ray Tritz, Jr., Remson, Ia.; S. E. Field, Ironwood, Mich.; V. C. Bailey, Evansville, Ind.; Daniel Block, Yeshwa University; N. D. Newby, Jr., Leonia, N.J.; Belle Nickels, Columbia, S.C.; Flood King, Stockton, Calif.; W. R. Warne, Alton, Ill.; May E. Richards, Northbrook, Ill.; Margaret Joseph, Milwaukee, Wis.; Max Beberman, Nome, Alaska; Hugo Brandt, Chicago; W. J. Cherry, Berwyn, Ill.

HIGH SCHOOL HONOR ROLL

The editor will be very happy to make special mention of high school classes, clubs, or individual students who offer solutions to problems submitted in this department. Teachers are urged to report to the Editor such solutions.

For this issue the Honor Roll appears below:

2049, 58. *John P. Lazarus, Long Branch, N. J.*

2053. *Bob Carlton, Hammond, Ind.; Rosalie Iverson, Oak Park, Ill.; George Kurze, Hammond, Ind.; Bobby Hamlin, Columbia, S. C.*

PROBLEMS FOR SOLUTION

2071. *Proposed by Grace E. Hicks, Austin, Texas*

Show that

$$\sin\frac{2\pi}{7}+\sin\frac{4\pi}{7}+\sin\frac{8\pi}{7}=\frac{\sqrt{7}}{2}.$$

2072. *Proposed by Hugo Braudt, University of Maryland*

In a right triangle ABC, angle $C=90°$, locate P on AB so that $AP=AC$. Also erect $BQ\perp BA$, with $BQ=BC$. Show that angle $PQB=\frac{1}{2}$ angle A.

2073. *Proposed by W. J. Cherry, Berwyn, Illinois*

Given a quadrilateral $ABCD$ with diagonal BD. If $DC=4$, $DA=7$, angle $CDA=80°$, angle $CBD=20°$, angle $ABD=35°$, find length of DB.

2074. *Proposed by Gay Eggers, St. Johns, Newfoundland*

If x, y, and z are lengths of the perpendiculars from any point within a triangle ABC, show

$$\frac{x}{a}=\frac{y}{b}=\frac{z}{c}=\frac{2\Delta}{a^2+b^2+c^2},$$

where Δ is area of the $\triangle$.

2075. *Proposed by D. J. Newman, The Bronx, New York*

Prove the identity:

$$\sin 1^\circ+\sin 2^\circ+\sin 3^\circ+\cdots+\sin 180^\circ=\cot(\tfrac{1}{2})^\circ.$$

2076. *Proposed by Norman Anning, University of Michigan*

If $A+B+C=180$, show that

$$4\cos\frac{A-B+C}{2}\cdot\cos\frac{A+B-C}{2}\cdot\cos\frac{B+C-A}{2}$$
$$=\cos^2 A+\cos^2 B+\cos^2 C+2\cos A\cos B\cos C-1.$$

CENTRAL ASSOCIATION OF SCIENCE AND MATHEMATICS TEACHERS—REPORT OF THE CHICAGO MEETING

The program of the 1947 convention was planned around the theme "Teaching Trends and Techniques." No field was left unsampled from philosophy, through theory, to the practical applications. No attempt will be made to cover the convention in detail. A Yearbook was sent to each member of the Association and the program as outlined in it was executed with thoroughness and efficiency. Mr. Hewitt, together with the members of his committees, deserve special recognition for their efforts in making the Chicago meeting such a success.

President George E. Hawkins was greatly missed by those who attended the convention. Everyone was sorry that illness prevented his observing the results of his handiwork. The efforts he had expended in the splendid organization of the convention were silent speakers for his wonderful foresight in planning the meeting. His place was capably filled by Vice President John E. Potzger, who presided at the general meetings.

A number of papers presented at the various meetings will appear in the official Journal, SCHOOL SCIENCE AND MATHMAETICS. Teachers who attend conventions such as these return to their classrooms stimulated to do more enthusiastic work.

MINUTES OF THE MEETING OF THE BOARD OF DIRECTORS

Those present were: Vice President John E. Potzger, Treasurer Ray C. Soliday, Acting Secretary Cecilia J. Lauby, Historian Edwin W. Schreiber, F. Olin Capps, Joseph Dickman, Charlotte L. Grant, Fred D. Leonard, Allen F. Meyer, Fred W. Moore, Mary A. Potter, Walter N. Smith, Bjarne R. Ullsvik, Kenneth Vordenberg, Arthur O. Baker, Geraldine Reep Johnson, Glen W. Warner, Glen F. Hewitt, Harold W. Haggard, and Emil L. Massey.

Vice President Potzger called the first meeting to order at 7:30 P.M., November 27, 1947, in the Berwyn Room.

Bjarne Ullsvik moved and Kenneth Vordenberg seconded that wishes for a speedy recovery be sent to President George E. Hawkins who was missed by all. Mr. Warner moved that the greetings be sent by telegram. Both motions carried.

Fred Leonard gave the report of the membership committee. He stated that Miss Catherine Bennett from West Terre Haute and Dr. Ella Marth from Harris Technical College in Missouri were appointed as additional members to the committee. Plans for reorganizing procedure so as to accomplish more were discussed.

Kenneth Vordenberg asked for suggestions of ways to contact teachers colleges and new teachers to acquaint them with C.A.S.M.T.—its scope, membership, and activities.

Allen Meyer moved, Mary Potter seconded, and it was passed that publicity with respect to membership be referred to the Resolutions and Policy committee who would discuss the question with the membership chairman.

Harold W. Haggar reported on the membership from the Chicago area. He

commented on the fact that there are some one hundred schools which do not have at least one membership in C.A.S.M.T. There are some four hundred memberships from two hundred schools.

Glen F. Hewitt reported on local arrangements. He stated that all equipment and facilities had been cared for. He reported 118 reservations for the luncheon and 88 for the banquet. He discussed the menu for both occassions. The trip to the Planetarium was also mentioned.

Geraldine Reep Johnson, editor and business manager of the Yearbook, reported on a most successful year. Ads and exhibit space were contracted for by forty-six advertisers, the largest number on record. The balance to the credit of the Association would be near eight hundred dollars—another record.

The procedure to be followed in the management and administration of the Yearbook was discussed. As it is now proceeding, some materials are sent to the editor of the Yearbook and some elsewhere. The Board favored the procedure of having all items concerned with the Yearbook to go directly to the editor of the Yearbook.

Ray Soliday moved that the Board authorize the Yearbook editor to issue a statement of deadlines and duties that other people concerned must follow in order that the administration of the Yearbook be completely under the Yearbook editor's control. It was seconded by Fred Moore. The motion carried.

Edwin Schreiber moved, Kenneth Vordenberg seconded, and it was passed that as a Board we extend our congratulations to Mrs. Johnson for her splendid work on the Year book.

Ray Soliday moved and Edwin Schreiber seconded that a telegram be sent to Secretary George K. Peterson extending our wishes for an early recovery. The motion carried.

Emil Massey was asked to report for the Journal committee. He asked Ray Soliday to give the report. Mr. Soliday stated that up to the present time the change in rates has not affected subscriptions to the Journal to any extent. He stressed the fact that the sale of back issues of the Journal has been an important source of income in increasing Journal subscriptions. Because of the uncertain conditions of the times, Banta cannot tell what we can expect in printing cost. However, the change to a saddle stitch will decrease the cost and give a slight increase in the printing space per page. The page size of the Journal will not change. The committee is endeavoring to publish as large a journal as possible without additional expense.

Mr. Warner, editor of the Journal, SCHOOL SCIENCE AND MATHEMATICS, called attention to one of the coming issues which will be on geography and contain a splendid article on the Grand Coulee Dam Project. Mr. Warner was able to collect some material for the Journal while on his trip through the South last summer. He urged members of the Board to help increase the flow of manuscripts for publication; he also asked for reviewers of books and textbooks.

The Historian, Mr. Schreiber, asked that he be notified of the death of any members of the Association.

Mr. Soliday, Treasurer, presented a written report on the financial status of the Association and stated the problems of back issues of the Journal and increase in printing costs. He discussed the additional but necessary expense of the audit of the accounts by a Certified Public Accountant. The Board informally agreed that the audit should be made.

Mr. Vordenberg moved, Mr. Ullsvik seconded and the motion passed that the report of the Treasurer be accepted.

The report of the Resolutions and Policy Committee was made by Ira Davis, chairman of the committee. The committee favored the appointment of subcommittees to keep the activities of the Association functioning between annual conventions. The Committee suggested the formation of five committees to study five projects:

1. Teacher Training.
2. Stepped up High School Program in Science and Mathematics.
3. Better Laboratories, materials, and visual aids.

4. Teacher research in the daily classes.
5. Better (simpler) evaluation techniques.

Mr. Davis expressed the opinion that membership in C.A.S.M.T. can be increased by giving teachers help in solving some of these problems.

Mr. Vordenberg moved that the Resolutions and Policy Committee work with the President in formulating sub-committees to work on the projects submitted by the Resolutions and Policy Committee. It was seconded by Mr. Baker. The motion carried.

Mr. Ullsvik suggested that the Resolutions and Policy Committee be allowed money to carry on their work and that this work be presented at section or general meetings next year. Mr. Meyer was of similar opinion that much benefit could be derived from bringing their activities before the Association. The Board was in agreement.

Mr. Schreiber moved that the Board appreciate the fact that such a project (Resolutions and Policy Committee project) cannot be carried on without expense and that as soon as the committee can make such a report the Board would be glad to receive such a report. Mr. Baker seconded the motion. Following a discussion the motion carried.

The report of the Anniversary Publication Committee was made by Mr. Schreiber. Mr. Schreiber moved and Mr. Baker seconded that $46.34 be forthcoming to the Committee on Anniversary Publication. Mr. Schreiber continued his report. He moved that $500 be set aside for the use of the Anniversary Publication Committee for the year 1947–48 and that additional annual allotments be forthcoming. The Chairman and the Treasurer are to countersign all checks. A discussion followed.

Mr. Vordenberg moved and Mr. Ullsvik seconded the motion that the report of the Anniversary Publication Committee be tabled until the Committee can give more details at the Saturday meeting of the Board. The motion carried.

Mr. Moore recommended that more information about the Anniversary Publication, its significance, etc. be presented by the Committee.

Mr. Baker moved that the Committee on the Anniversary publication report and make some suggestions on pre-publication publicity for the Anniversary Publication at the Saturday meeting of the Board. Seconded by Mr. Vordenberg. The motion carried.

Mr. Dickman moved and Mr. Soliday seconded that the meeting adjourn. The motion carried.

The meeting was adjourned. (10:05 P.M.)

THE SATURDAY MORNING BUSINESS MEETING

The meeting was called to order at 8:18 A.M. in the Berwyn Room. Presiding was Vice President John E. Potzger.

Mr. Fred Leonard, chairman of the Membership Committee, reported that 411 members and 117 guests had registered on Friday. This was about 100 less than the Detroit attendance. The present membership of the Association exceeds 1200.

Mrs. Johnson, editor of the yearbook, reported the most successful year to date. Returns from 46 advertisers and exhibitors make possible a profit approximately eight hundred dollars. This was a record year for the yearbook.

Mr. Milton D. Oestreicher, chairman of the trip to the Planetarium, reported that the trip would leave as scheduled.

Mr. Carl F. Hanske, chairman of the Place of Meeting Committee, reported that Indianapolis, Indiana was recommended as the 1948 Convention City.

Mr. Walter H. Carnahan, chairman of the Nominating Committee, gave his report as follows:

Board of Directors for three years
Donald W. Lentz, Ridge Road School, Parma, Ohio
Vernon H. Price, University High School, Iowa City, Iowa
Loren M. McKenzie, Upper Canada College, Toronto, Ontario, Canada

Ralph W. Lefler, Purdue University, Lafayette, Indiana

Mr. Ullsvik moved and Mr. Moore seconded and it was passed that a unanimous ballot be cast for these members.

Vice President Miss Mary A. Potter, Board of Education, Racine Wisconsin

Mr. Soliday moved, Dr. Grant seconded and it was passed that a unanimous ballot be cast for Miss Potter.

Mr. Carnahan then took the chair and completed his report. The Nominating Committee recommended for President, Dr. John E. Potzger, Butler University, Indianapolis, Indiana.

Mrs. Wilcox moved, Mr. Soliday seconded and it was passed that a unanimous ballot be cast for Dr. Potzger. Mr. Carnahan retired from the chair.

Dr. Potzger spoke warmly of the cooperation and help he had received from the Association enabling him to carry on this meeting in the place of Mr. George E. Hawkins, the 1946–47 President who is ill.

Mr. Cecil Read of Wichita suggested that the Business Meeting of the Association be held as a part of the General Meeting on Saturday morning. Dr. Potzger stated that the suggestion would be referred to the Committee on Arrangements.

Mr. Glen Ayre suggested that the chairmen of the Saturday group meetings be invited to attend the meetings which plan the speakers for the convention. It would aid them in obtaining suggestions.

The meeting was adjourned.

THE SATURDAY AFTERNOON MEETING OF THE BOARD

The meeting was called to order by Dr. Potzger at 1:45 P.M. in the Berwyn Room.

Mr. Schreiber moved, Dr. Grant seconded that the Board express its thanks to the retiring members of the Board of Directors for their faithful work and loyal support of the Association.

The report of the Anniversary Committee which had been tabled at the Friday meeting was again presented.

Mr. Schreiber asked Mr. Teeters to give a resume of the information he had secured from various publishers as to the approximate cost of publishing the Anniversary Publication.

Mr. Teeters reported that estimates ranging from $1.36 to $6.00 each per 1000 copies, had been received. The lowest estimate was by Laidlow, at $1.36 each, per 1000 copies; the American Book Co., $1.69. Printers were also contacted and gave estimates from $1.85 to $2.23. Scott, Forsman's estimate of cost was $2.22.

Mr. Schreiber estimated that the publication would cost between $2.25 and $2.75 per copy. The content would consist of some ten to twenty pages containing photographs, diagrams, etc. The publication would contain information about past officers, section meetings, history of the Journal, SCHOOL SCIENCE AND MATHEMATICS, past meeting places and a chapter on advertisers and advertising.

Mr. Schreiber then explained how he intended to budget the $500 for which the Committee on the Anniversary Publication had asked the Association:

$100 collecting and tabulating source material.

$100 typing, duplicating, stencils, etc.

$50 postage, telegrams, etc.

$50 to $100 meetings of the five members of the committee.

$50 miscellaneous.

Mr. Schreiber suggested that we might get fifty people out of C.A.S.M.T. who would underwrite to the extent of $20 each to cover the cost of this Anniversary Publication.

Mr. Vordenberg inquired whether the publication would be only a personal history of the organization or whether the publication would include the contributions of C.A.S.M.T. to science and mathematics teaching.

Mr. Baker expressed the opinion that the Anniversary Publication should show definite contributions of educational trends in mathematics and science.

Dr. Grant thought that implications and implementations should also be included.

Mr. Ullsvik thought the publication was to be one showing trends, etc. rather than a history of the sections.

Mr. Schreiber said that it was the unanimous agreement of the Committee on Anniversary Publication that the original idea of showing trends, etc. was too big an undertaking. Such a publication would cost $10,000.

Mr. Soliday, Treasurer, was asked for his opinion. He stated that times being what they are it is difficult to tell how our financial conditions will remain. We have made $1500 from the sale of back issues of the Journal, but with the increased rates we may lose some memberships, and printing costs are high. He thought that improvement of conventions and improvement of the Journal should have first call on the finances of the Association.

Mr. Lefler asked how history was defined by the members of the Anniversary Committee. To them, was history dates and names or the contributions of the Association to the fields of teaching in mathematics and sciences?

In the discussion which followed it was stated that if the Anniversary Publication was a publication of trends, such a book would be of value for promotion purposes for five years. It was also suggested that the Anniversary Publication could be part of the official Journal or one issue of the Journal could be called the Anniversary Publication.

Mr. Schreiber moved that the Board of Directors underwrite the sum of $500 to be used between this annual meeting and the next for the publication of the anniversary book. It was seconded by Mr. Baker. The motion carried.

Mr. Vordenberg gave the report of the committee appointed by Mr. George Hawkins to nominate a Secretary. Mr. George Peterson, because of illness, wished to be relieved from his duties as Secretary. It was moved and seconded that Cecilia J. Lauby be elected as Secretary to succeed Mr. Peterson. The motion carried.

Mr. Vordenberg moved, Mr. Capps seconded the motion that Indianapolis, Indiana be accepted as the Convention City in 1948. The motion carried.

Mr. Vordenberg moved and Mr. Soliday seconded the motion that the 1949 and 1950 conventions be held in Chicago. The motion carried. It was suggested that the Edgewater Beach Hotel be tentatively reserved for these conventions.

It was suggested that the banquet committee together with the President arrange for convention banquets. It was also recommended that there be only one dinner meeting at each convention and that this be either an elaborate noon luncheon or an evening banquet.

The possibility of the Saturday Board meeting being held as a luncheon meeting so as to get an earlier start was discussed.

A need for a study of the By-laws was suggested.

Dr. Potzger stated that the spring Board meeting would be held the third Saturday in May at some geographically centered place, possibly Chicago, but the place would be decided later.

The meeting was adjourned.

The minutes of the three meetings are respectfully submitted.

CECILIA J. LAUBY, *Secretary*

THE SECTION MEETINGS

The various section meetings of the Association held on Friday afternoon and the group meetings held on Saturday morning met the high standards established in the general meetings. The Journal, SCHOOL SCIENCE AND MATHEMATICS, will publish as many papers as are available. Refer to the 1947 Yearbook as a source of information relating to the various meetings. If more definite information is desired, please write to the undersigned or to the chairman of the meeting in question. Officers for the sections were elected in accordance with the by-laws of the Central Association of Science and Mathematics Teachers. The full roster of officers for 1947–48 appears in this issue of the Journal.

CECILIA J. LAUBY, *Secretary*

BIOLOGY SECTION

Mr. O. D. Roberts, chairman of the biology section, called the meeting to order on Friday afternoon at 2:15 P.M. in the North Room of the Edgewater Beach Hotel and introduced the first speaker, Dr. E. Lawrence Palmer, School of Education, Cornell University. Dr. Palmer gave an address on "The Contribution of Yearbooks to Science Education." It was pointed out that yearbooks should give representative pictures of situations; that many scientific inaccuracies have appeared in yearbook materials; that invalid information should not be printed as valid; that the forty-sixth yearbook implies unfairly that nature study is taught in the schools by the use of much exotic material; that material otherwise exotic ceases to be so when it is actually before the pupils; that in the forty-sixth yearbook for science education too much importance is given to survey and orientation courses; that the trainer of science teachers should know at least as much as those he is teaching; that some workers imply that the higher you go in science education the less training you need to teach in science; that the forty-sixth yearbook may be less satisfying than the thirty-first; and that the forty-sixth yearbook may be a distinct disservice to education. The speaker stated that the yearbook might have discussed the phenomenal use of radio in education, the advance of conservation education, the present nutritional problems, the place of quick freezing in man's progress, the value of including education on radiant heat and solar energy, the educational aspects of insect controls—D.D.T. and other insecticides, and the place of recordings for teaching purposes—bird calls, calls of amphibians, etc. Recordings were played of "Voices of the Night" and brief comments were made on the use of such materials in teaching children. Attention was called to the fact that the young people of the generation need accurate information in science. Some yearbooks seem to have aided education—others seem to have deterred it.

Mr. A. C. Brookley, Thornton Township High School, Harvey, Illinois, chairman of the nominating committee, recommended the officers for the coming year. The report of the nominating committee was accepted by unanimous ballot. The officers for 1948 are:

Chairman—Helen Trowbridge, Biology Instructor, Glenbard High School, Glen Ellyn, Illinois.

Vice-chairman—R. H. Cooper, Associate Professor of Biology, Ball State Teachers College, Muncie, Indiana.

Secretary—Donald B. O'Brien, Biology Instructor, Thornton Township High School, Harvey, Illinois.

Dr. J. E. Potzger, Department of Botany, Butler University, Indianapolis, Indiana, spoke on "The March of Forests in Eastern North America." The speaker pointed out that some of the life forms of yesterday left silent records while others left no record and that everything in nature has a label if we just know how to read it. In preparing the audience for his data on the bogs of Indiana and Michigan Dr. Potzger showed charts with diagrams of some common pollen grains. These were described and identified. The instrument for taking bog samples was shown and the function of its parts explained. A short account was given concerning the laboratory follow-up on the samples. The deepest bogs were found in Indiana and the shallower ones in Michigan. From the findings in bog samples taken from the lowest foot levels through to the surface level, pollen profiles were constructed. Dr. Potzger showed several lantern slides of pollen profiles which gave a revealing account of the general forest succession for the area involved.

Manuscripts of the addresses by each of the above speakers will be made available for publication in the Journal.

R. H. COOPER, *Secretary*

CHEMISTRY SECTION

Mr. Loren T. Lucas, Lake View High School, Chicago, Chairman of the Section called the meeting to order in the Sheridan Room of the Edgewater Beach Hotel.

He first introduced the other two officers, Vice chairman Allen F. Meyer of Mackenzie High School, Detroit and Secretary Carl E. Ekblad, Senior High School, Moline, Illinois. Dr. Shailer L. Bass, Assistant General Manager, Dow Corning Corporation, Chicago, the first speaker, was then introduced. His topic was Silicones, what they are and what they are doing. Dr. Bass outlined by aid of slides the chemistry of the silicones and methods and problems connected with their manufacture. Dr. Bass also displayed a large number of samples of silicone products.

Mr. James R. Irving of Maine Township High School, Park Ridge, Illinois, was the second speaker. Through his topic, "The Teaching of Chemical Reactions Can Be Fun," he showed how such subject material as chemical reactions and equations can, by comparison with football plays and other similar situations with which the high school student is familiar be made both interesting and instructive. He distributed a printed sheet containing a summary of fundamental inorganic chemical reactions. Mr. Irving also presented and explained the mechanical details of a rectangular box model of the Periodic Chart, so constructed that by means of a series of light bulbs and switches all or numerous combinations of the symbols on the chart could be illuminated. This model had been made by some of his students under his supervision.

Manuscripts of the two topics presented at the meeting will be made available for publication in this Journal.

The chairman of the nomination committee, Mr. John Chiddix presented the names of the following persons who were unanimously elected: chairman, Allen F. Meyer; vice chairman, Carl E. Ekblad; and secretary, Clyde W. Dewalt.

CARL E. EKBLAD, *Secretary*

ELEMENTARY SCIENCE SECTION

The annual meeting of the Elementary Science Section of the Central Association of Science and Mathematics Teachers was called to order on Friday, November 28, 1947 at 2:15 P.M. by the chairman, Miss Illa Podendorf. The minutes of the last meeting were read and approved. Miss Podendorf announced a nominating committee composed of Miss Hildegard Pieper, chairman, Miss Anna De Merse, and Miss Ruth Krumhansl.

Miss Gretchen Barton of the Row Peterson Publishing Company gave a very worthwhile demonstration lesson on the unit "Plant Factories." Pupils of the fifth grade class of Peirce School in Chicago took part in the demonstration. Miss Barton presented the work in an interesting manner. By the time the lesson ended the children decided that all of the food they planned to have for breakfast,, lunch and dinner came from plants. Books were used to check their conclusions.

Miss Edna Byrne, a teacher of Miles Standish School in Cleveland gave a most interesting and helpful talk on the fifth grade science unit "What Makes the Weather Change?" Miss Byrne discussed many phases of the unit; such as, how the unit began, activities to aid in learning about weather, correlations, and evaluation of the unit. She brought out the fact that the study of weather in the fifth grade is not intended to make the children prospective weather men but, rather, to open new avenues of interest.

An instructive exhibit of materials that had been made by the children in Miss Byrne's class helped to show that the study of weather offers many opportunities for observing, for experimenting, for gathering and recording data and for correlation with such subjects as English, geography, art, handcraft, and arithmetic.

Miss Dorothy Miller, Iowa State Teachers College, Cedar Falls, Iowa, presented a paper on The Place of Elementary Science in the Curriculum. She contrasted the old definition of Science as "organized knowledge," with Dr. Conant's statement that " . . . science emerges from the other progressive activities of man to the extent that new concepts arise from experiments and observations, and the new concepts in turn lead to further experiments and observations."

Miss Miller pointed out that the pre-service training of most Science teachers is very inadequate, and that the place of Elementary Science in the curriculum is

governed by the teacher who presents it. A knowledge of science, she stated, will do the following for the individual:

1. Make life more interesting.
2. Satisfy a natural curiosity.
3. Overcome superstitions.
4. Stimulate the development of cause-and-result relationship thinking.
5. Develop realization of the fact that there are unknowns.

Miss Pieper made the report of the nominating committee and the following officers were elected for the coming year:

Chairman: Mrs. Marion Wanless, Poe School, Detroit, Michigan.
Vice Chairman: Miss Viola Neuman, Miles Standish School, Cleveland, Ohio.
Secretary: Miss Viola Henrikson, Girls Latin School, Chicago, Illinois.

VIOLA NEUMAN, *Secretary*

GEOGRAPHY SECTION

The Geography Section met in the East Lounge of the Edgewater Beach Hotel on Friday afternoon, November 28th. Through the interest and cooperation of the Denoyer-Geppert, A. J. Nystrom, Rand McNally and Weber-Costello companies, maps and globes were on display and furnished a functioning background for the program of the afternoon.

The Chairman, Miss M. Louise Anderzohn of Irving School, Oak Park, presided. Since the Secretary, Dr. Floy Hurlbut, was in China, the Vice-Chairman, Miss Villa Smith, was aked to serve as Secretary pro tem.

During the short business meeting the nominating committee made its report and the following officers were elected for the ensuing year:

Chairman, Miss Ester A. Arthur, South Shore High School, Chicago.
Vice-Chairman, Dr. Floy Hurlbut, Ball State Teachers College, Muncie, Indiana.
Secretary, Miss Laura L. Watkins, Lincoln School, Cicero, Illinois.

The program of the afternoon was exceptionally fine. Seldom has it been our good fortune to have so many recognized leaders in the field of geography or to have a more interesting or timely discussion.

Dr. Chauncy Harris, Professor of Geography, University of Chicago, spoke on "Utilizing the Earth." He presented and interpreted the distributional aspects of earth resources and peoples; the distributional aspects of agricultural and manufacturing activities.

Dr. Harry Lathrop, Head of the Department of Geography, Normal University, Normal, Illinois, served as Chairman of a Map Clinic at which the minimum needs in globes and maps were presented and discussed for the following grade levels:

Elementary level—Isabel K. Billings, Hawthorne School, Oak Park.
Upper Elementary level—Laura Watkins, Lincoln School, Cicero, Illinois.
Junior High School level—Monica Kusch, University of Illinois, Navy Pier, Chicago.
High School level—Mrs. Elizabeth Lickton, Waller High School, Chicago.
College level—Dr. Edward B. Espenshade, Northwestern University.

The discussion concerning maps and globes was concluded with short talks by
Mr. O. E. Geppert, of Denoyer-Geppert Co.
Mr. C. A. Burkhart of A. J. Nystrom Co.
Mr. Davis E. Sites of Rand McNally Co.
Mr. John Guthrie of Weber-Costello Co.

These map and globe makers and distributors did more than call attention to the products of their respective companies. They recognized the problems of geography instruction at all levels of learning, and considered maps and globes as essential tools.

VILLA B. SMITH, *Sect. pro tem*

MATHEMATICS SECTION

The meeting was called to order at 2:15 P.M. by the section chairman, Mr. H. Vernon Price, University High School, Iowa City. Mr. Price introduced his staff officers, Vice-Chairman Philip Peak, University High School, Bloomington, Indiana, and Secretary W. H. Edwards, Redford High School, Detroit, Michigan.

The minutes of the previous meeting were read and approved.

The following were appointed to function as a nominating committee:

Mr. Stanley F. Schenk, Goshen, Indiana
Mr. Franklyn Frey, Detroit, Michigan
Mr. J. C. Taccola, Hinsdale, Illinois

This committee later reported their recommendations for 1948 as follows:

For Chairman
Mr. Philip Peak, Bloomington, Indiana
For Vice-Chairman
Mr. W. H. Edwards, Detroit, Michigan
For Secretary
Mr. E. H. C. Hildebrandt, Evanston, Illinois

This report was endorsed by the membership.

Mr. Cecil B. Read, Department of Mathematics, The Municipal University of Wichita, Kansas, was the first speaker. His topic was "Criticism of Certain Aspects of High School Mathematics Texts." Mr. Read has an authoritative and extensive acquaintance with mathematics texts by virtue of his long service as critic for publishing firms and from private analytical studies of texts. Mr. Read cited numerous instances of error, inconsistency, conflict, and misdirection in definitions, explanations, and diagrams in texts. Comment was made upon the general incompleteness in the indexing of mathematics texts.

Mr. Raleigh Schorling's address "What's Going on in Mathematics," concerned itself with some aspects of the reports of the Cooperative Committee on the teaching of Science and Mathematics. Mr. Schorling, who was on leave of absence from the University of Michigan to serve on this presidential committee, gave a brief historical survey of the committee and its work. He made a strong plea that action be taken on the committee's recommendations and material so that the work in the classrooms be actually influenced.

After discussion from the floor on Mr. Read's and Mr. Schorling's papers the meeting adjourned at 4:00 P.M.

W. H. EDWARDS,
Secretary

ELEMENTARY MATHEMATICS SECTION

(1) Experimental Work in Arithmetic in the Chicago Public Schools, Joseph J. Urbancek, Chairman, Mathematics Department, Chicago Teachers College.

About two years ago a committee from the Chicago Public Schools was selected to conduct a survey, in the system, through the medium of a questionnaire sent to the elementary teachers. The work was expedited through the cooperation of the administration and teachers. An analysis of the types of problems that teachers said existed fell into the following seven major areas.

Types of Difficulties of Reading in Arithmetic

I. Vocabulary Difficulties
II. Mechanics and Reading Difficulties
III. Arithmetical Difficulties
IV. Teaching Difficulties
V. Textbook Difficulties
VI. Problem Analysis
VII. Reasoning Difficulties

Other Types of Difficulties—Comprehension

Ability to

I. find the main idea as applied to arithmetic
II. relate minor ideas to the central thought
III. follow directions
IV. see the relationship of ideas in order to predict an outcome or to form a conclusion
V. retain necessary and relevant ideas

Success Factors in Mathematics

I. Reading
II. Computation
III. Number relations
IV. Meaning
V. Quantitative thinking
VI. Memory

The first seven categories of difficulties, listed above, prompted the committee to solicit from the teachers techniques and teaching devices that they found effective in helping children overcome their troubles. It was felt that there were many good teachers in the school system who had sufficient ingenuity and vision to overcome whatever problems they met in their teaching. More than 1,200 such techniques and devices were submitted.

The teachers on today's Panel are here by invitation to present to you some of their methods and techniques which we felt were worthwhile and which we felt you should hear and see.

The four teachers listed on the panel delivered excellent oral reports with materials showing how they help students understand Arithmetic better. The audience showed much interest and participated in the discussions.

(2) Panel Discussion, Joseph J. Urbancek, Chairman

Practical Applications of Reading in Arithmetic

Reading and Writing Numbers, Mabelle Linstrom, Armstrong School.
Arithmetic Vocabulary, Louise Navigato, Morris School.
Teaching Fractions, Margaret Stanton, Burley School.
Problem Solving, Valentine Casey, Morse School.
Section Officers: Albret H. Goodrich, Chairman; Marie W. Sperks, Vice Chairman; Joseph J. Urbancek, Secretary.

BOOK REVIEWS

COLLEGE PHYSICS, by John A. Eldridge, *Professor of Physics, University of Iowa.* Third Edition. Cloth. Pages x+720. 13.4×21.5 cm. 1947. John Wiley and Sons, Inc., 440 Fourth Avenue, New York 16, N. Y. Price $4.50.

The most important comment that we can make here is that an excellent text has been made better. No great changes have been made but the Third Edition will please more teachers than the Second Edition because of the rearrangement of the chapters in Mechanics. After the three short preliminary chapters which tell the student the general content of the subject of physics and give him the elements of accurate measurement, the text proceeds as follows: 4. First Law of Statics: Balanced Forces, 5. Second Law of Statics: Balanced Torques, 6. Uniformly Accelerated Motion, 7. Forces and Motion, 8. Examples of Forces, 9. Work and Energy, 10. Simple Machines. Then follow the chapters on lLiquids, Gases, and Elasticity, which were discussed in chapters 4, 5, and 6 in the previous book. In the remainder of the text no great changes occur except the omission of the short chapter on Electromagnetic Theory: Relativity. In a great

number of paragraphs throughout the book sentences have been changed to clarify the meaning, new or additional statements have been added, or recent discoveries told. A page of answers to the problems in the text is given in the Appendix.

As the book now stands it will certainly please a greater number of teachers than did the first and second editions even though little change in the content has been made. The original book was excellent. The author has now ironed out the wrinkles and probably few additional changes will be made in future editions except the addition of new developments as they take place.

G. W. W.

CHEMISTRY MADE EASY, by Louis T. Masson, B.S., Ed. M., *Riverside High School, Buffalo, New York*. Cloth. 416 pages. 13×19 cm. 1947. School Science Press, 342 Norwalk Avenue, Buffalo 16, N. Y. Price $1.79; Student Special Volume in leatherette $1.00.

Here is another of Louis T. Masson's High school texts following the same general plan as his previous books, *General Science Made Easy* and *Physics Made Easy*. His aim has been to put out a text that will appeal to the high school student, give him a limited number of basic ideas to master, and show him their values and uses in daily life. He has used the "visograph" idea of illustrations developed in his two previous texts. Many of these are excellent for teaching important chemical principles without other comment: some are so complicated that considerable class time will be necessary to make them clear. This may be a very effective method of teaching because most of our high schools are now pretty well filled with youngsters who will never be able to study anything that cannot be presented in some form of picture, play, or game.

Following each chapter there is a good set of questions which will help the student to master the content and give the teacher a ready-made preparation assignment. One or more completion exercises, multiple-choice, or true-false tests are also used at the end of each chapter. Other similar tests and reviews follow important topics. The last chapter contains a table of famous scientists and their contributions to chemistry; a glossary of chemical terms; a list of important chemicals, their common names, chemical formulas, and important uses; a table of chemical tests; and a number of other tables for reference.

G. W. W.

THE STORY OF WOOL, by William F. Leggett, *Associate Technical Editor, Rayon Textile Monthly. Author of Ancient and Medieval Dyes*, and *The Story of Linen*. With a Foreword by SYLVAN I. STROOCK. Cloth. Pages vi+304. 12×19 cm. 1947. Chemical Publishing Company, Inc., Brooklyn 2, New York. Price $5.00.

This story, written by an expert in the textile field, reflects long study and careful gleaning of facts relating to wool, and provides a study of the evolution of industrial history from ancient to modern civilization through the development of wool and wool textile artistry. The student of animal husbandry will find a wealth of material on the history of selective breeding of sheep for better qualities of fleece. Textile technicians and engineers and all workers in the textile fields will be interested in the story of the habits and cultures of ancient craftsmen. Many other side lights of the history of wool in relation to its raw and manufactured products are presented from the point of view of the cloth merchants, weavers, bankers, sheep raisers, shepherds, farmers, churchmen, consumers of fine fabrics, and shrewd and stupid rulers. In addition to the story of wool and the sheep that produce it, there are brief chapter on other fleece and fur bearing animals which provide fibers for the manufacture of fine cloth.

ESTIL B. VAN DORN
George Washington High School
Indianapolis, Ind.

TELEVISION PRIMER OF PRODUCTION AND DIRECTION, by Louis A. Sposa, *Di-*

rector of Commercial Operations, Television Station WABD, New York Television Instructor, College of the City of New York and New York University. Cloth. Pages viii+237. 13.5×20.5 cm. 1947. McGraw-Hill Book Co., Inc., 330 W. 42nd St., New York 18, N. Y. Price $3.50.

The author wishes to inform the public that television should be known not as a glamorized, furbelowed, distorted fantasy, but simply as a medium of electronic circuits, ideas, entertainment, and service. In each chapter there is a clear but simple description of each factor that is necessary in the broadcasting of visual images by electronics. It is also implied that the visual image be broadcast synchronously with sound.

Contents: Television—What Is It? The Television System. The Camera. Lighting for Television. Scenic Design. Titles and Video Effects. Costuming, Make-Up. Microphones, Sound, and Sound Effects. Motion-Picture Film in Television. Scripts. Commercials. Production and Direction. Programing. Television's Future. Appendix. Recommended Reading. Glossary of Television Terms. Index.

ESTIL B. VAN DORN

ARITHMETIC, GRADES 6, 7 AND 8, by Clifford B. Upton, *Teachers College, Columbia University* and Kenneth G. Fuller, *Teachers College, New Britain, Connecticut.* Grade 6. Cloth. Pages vii+312+xix. 13×20.5 cm. 1946. Price $1.20. Grade 7. Cloth. Pages vii+328. 13×20.5 mc. 1947. Price $1.24. Grade 8. Cloth. Pages vii+360. 13×20.5 cm. American Book Company, 88 Lexington Avenue, New York 16, New York.

Four aspects of arithmetic, the informational, the computational, the social, and the interpretational, are recognized and treated in this series of books. The general plan is to introduce each new topic with a concrete, motivating problem based upon social factors with which the pupils are familiar. From this the calculations are made and explained. The explanations are given in simple language and are brief. The spiral system of development is used throughout; each book reteaching on a broader basis important topics of preceding grades. Use is made of historical, geographical and scientific material, particularly in book six, in organizing a whole series of exercises. For example, the first few pages of this book are devoted to a group of problems based on The Lewis and Clark Expedition. At intervals throughout the texts there are vocabulary exercises called "The Language of Arithmetic," which include the meaning of common expressions used in mathematics. There are diagnostic tests with references for the pupil to remedial exercises. He is told their purpose so that he may be encouraged to improve himself.

Problem solving begins with one step problems and includes all types of quantitative thought that are possible in connection with each of the four fundamental operations. There are problems for which the pupil must formulate questions; problems with missing data or with extra data; problems without numbers and problems requiring estimated answers. Use is made of tables such as interest tables and square root tables and practice in their use is given. Graphing is included in all three texts with the emphasis on reading and interpretation. Many of the illustrations in the sixth grade book are in color. Those in the seventh and eighth grade books are in black and white and for the most part are of the functional or associative type. That is to say, they are illustrations that "teach" or are closely associated with an idea expressed in a problem or unit and are not merely decorative.

Although these texts embody many of the desirable changes that have been made in recent mathematics textbooks, several observations seem worthy of mention. If these texts are to provide a continuous and integrated program in *meaningful* mathematics, the understanding of our number system and of the rationale of the computational processes should be much more systematically developed and maintained. The concept of place value, one of the key concepts,

is dealt with very lightly in the sixth grade and practically not at all in the seventh and eighth grade books. Practice is given for the maintenance of the processes but there is no corresponding *explicit* maintenance program for understandings—for the recall of generalizations about the number system of the type which must be developed if the meaning program is to be effective; for example the principles of place value and those which explain carrying and borrowing. Even if it is assumed that the junior high school pupil should be in possession of most of these principles, some extension and enrichment of meaning is desirable.

The content of these texts like most recent mathematics textbooks is a mixture of pure and applied arithmetic, informal geometry, trigonometry, simple algebra and graphs. There has been some effective integration of these materials but the integration is far from complete. The program lacks unity or coherence—a unit on informal geometry is sandwiched between units of content that are predominantly arithmetical. This provides variety and the lack of coherence or unity will probably not be noticed by the pupils. But when it is assumed that learning proceeds best when the numerous and varied activities are unified around a few central ideas, then more attention to methods of securing unity seems desirable. For example, the notion of *comparison*, with emphasis upon comparing by difference and by ratio, is well suited to serve as one of the unifying ideas. The understandings or meanings associated with comparison are key concepts in quantitative thinking. They may be applied over and over again in the treatment of many kind of data and consequently are suitable for helping the pupils to become aware of unity and coherence in the program. The particular choice of unifying concepts or methods is, however, of less importance than that they exist.

On the whole these books are a uasable and flexible tool for teachers. No single book can provide within its limited dimensions driving power, enthusiasm, background, the stimulus of constant guidance and correction, unified interweaving and new outlooks. All the paint brushes in the world and miles of canvas are of no avail when the trained hand of the skillful artist is removed from the scene. In the same way mathematics can be taught effectively only by the skilled teacher who first of all knows her children and secondly is an eager student of the limitless possibilities of her subject.

HELEN SCHNEIDER
Oak School, LaGrange, Ill.

THE MATHEMATICAL THEORY OF FINANCE, by Kenneth P. Williams, *Professor of Mathematics, Indiana University*. Revised edition. Cloth. Pages x+274. 14.5×22 cm. The Macmillan Company, New York. Price $4.50.

This is a revision of a text which first appeared in 1935. In the revision lower interest rates have been employed in many problems, in accord with current usage. However in the tables (taken from Glover) the lowest interest rate is ½%, which may cause difficulty in handling problems involving a very low nominal rate converted several times a year.

The American Annuitants' Table of Mortality used in the earlier edition is now replaced by the 1937 Standard Annuity Mortality Table. Likewise the life insurance tables are on a 3% basis replacing the 3½% tables. The author gives more historical material about such tables than is found in many books; he discusses trends toward using modern mortality tables.

The problems in the revised edition have, to a large extent, been changed by a modification in the given data. The general method of treatment assumes the student will solve by logarithms rather than calculating machine, however tables in general give both the actual values and the logarithms of such values. Problems appear in two lists, usually of equal difficulty, thus providing alternate sets of exercises. In addition there is a set of 121 supplementary exercises; answers are given to more than half, but not all problems. In the revised edition algebraic exercises have in several cases been segregated.

The subject matter in the revised edition follows with relatively minor changes that of the original text. The subject matter is largely traditional, no unusual

notations were noted. An appendix covers briefly certain algebraic topics which may need review: binomial theorem, progressions, logarithms.

The paper is definitely of poor quality; with only eight pages less than the first edition the book is only three-fourths as thick. Typography is in general good, an exception is page 67. On the whole the book is distinctly above average.

J. RAY HANNA
CECIL B. READ
University of Wichita

CALCULUS, by G. E. F. Sherwood, *Professor of Mathematics*, and Angus E. Taylor, *Associate Professor of Mathematics, University of California at Los Angeles.* Revised Edition. Cloth. Pages xiv+568. 16×23.5 cm. Prentice-Hall, 70 Fifth Avenue, New York. Price $3.75.

This is a revised edition of a beginning calculus text, which in the original edition treated the subject matter with considerably more rigor than many texts. (For example, the distinction between the double and the iterated integral; Cauchy's principle of convergence; Duhamel's principle.) There have been no radical changes from the first edition. A few topics previously mentioned are no longer included, as for example, uniform continuity.

Although there is a very brief discussion of the inverse of differentiation in the fourth chapter, the text does not include any extensive amount of integration early in the book. If the course is such that the treatment of integration is postponed until the second semester, this text warrants careful consideration. On the other hand, it will probably not satisfy the teacher who wishes to take up integration of simple functions, together with applications, during the first semester.

CECIL B. READ
University of Wichita

COLLEGE ALGEBRA, by M. Richardson, Ph.D., *Assistant Professor of Mathematics, Brooklyn College.* Cloth. Pages xvi+472. 16×23.5 cm. 1947. Prentice-Hall, Inc., 70 Fifth Avenue, New York. Price $2.85.

Although the subject matter of this text is for the most part conventional, there are several topics treated more fully than in many texts. The introductory chapter on the number system of algebra, the work on interpolation and curve fitting, and a proof of the theorem on partial fractions, are illustrations of matter not usually incorporated.

The author has made a conscientious attempt to use rigorous proofs whenever possible. When this seems beyond the capacity of the student, it is clearly pointed out that the discussion presented does not constitute a proof. The order of topics in the book is somewhat unusual, but in general the matter is so arranged that chapters can be taken in some other order than that of their appearance. The number of problems seems ample.

The quality of paper in the review copy seems definitely inferior. The typography is good. A couple of minor points were noted: in the glossary of symbols the Greek letter delta is defined as the first difference, but in Chapter 16 the symbol is used for the value of a determinant; in an attempt to again refer to the discussion of a negative exponent, it was discovered that the topic was not mentioned in the index.

CECIL B. READ

MATHEMATICS AS A CULTURE CLUE AND OTHER ESSAYS, by C. J. Keyser, *Adrian Professor Emeritus, Columbia University, New York.* Volume I of *The Collected Works.* Cloth. Pages vii+277. 13.5×20.5 cm. 1947. *Scripta Mathematica*, Yeshiva University, Amsterdam Avenue and 186th Street, New York, N. Y. Price $3.75.

A group of twelve essays having as a central theme the nature of mathematics as a manner of thought. One set of essays deals more directly with this theme,

while a second set gives review discussions of the principal works and ideas of such men as Hilbert, Korzybski, Russell, Peirce, and Pareto. A third set discusses particular philosophical and logical considerations inherent within mathematics.

In only one essay, THE THREE GREAT SYNONYMS, are more definite mathematical ideas discussed. The others are written for the cultured layman type of reader. The few strictly mathematical concepts presented are done on this level.

The statement of the publication committee that " . . . (they) believe that by making the collected works available to the public, . . . (they are) rendering a genuine service to the cause of clear thinking," suggests that the volume may be read without too much difficulty by other than scholars or philosophers. Indeed, the scientist, mathematician, or general reader should find much of interest in this group of thought provoking essays.

W. K. McNabb
Dallas, Texas

RAW MATERIALS FROM THE SEA, by E. Franklin Armstrong, and L. Mackenzie Miall. Cloth. Pages viii+196. 13.5×21.5 cm. 1946. Chemical Publishing Company, Inc., Brooklyn 2, N. Y. Price $3.75.

This book is definitely beyond the high school level, probably finding its keenest readers in the practicing chemical engineer or geologist and the college chemistry, geology or related science major. *Raw Materials from the Sea* depicts the sea as a dilute solution of most of the elements and as a rich source of mineral wealth. Geologic history along with complex, continuously occurring chemical and physical changes are freely used to explain the present analysis of sea water. The methods developed in the past and now being used for extracting salt, bromine, magnesium, iodine, and potassium from sea water are elaborately discussed. An appendix outlines the analytical methods for assaying the content of sea water.

The authors draw together many branches of science in their discussion of the topics. For instance, in the section dealing with the precipitation of potassium salts by evaporation, the phase rule of Gibbs and phase diagrams for two and three component systems in equilibrium are brought into the discussion. The book is fully documented with a large number of technical and scientific studies.

In style, *Raw Materials from the Sea* is devoid of flowery, literary garnishment (except for an occasional poetic quote before a chapter). With the most simple, lucid English imaginable, the authors pack into their little volume an immense quantity of factual detail. Such a style carries a kind of integrity by its avoidance of adjectives of degree or by emotional appeals. The use of the proper noun, "Dow Company," with the verb "have" on page 81 and the verb "are" on page 84 at first appeared to be grammatical errors, but it is possible these are customary in Great Britain, since the authors are British in all probability. In closing this review, one can safely say that the book is profitable reading for high school science teachers.

SHELDON S. MYERS
Western State High School
Kalamazoo, Michigan

GETTING A JOB IN TELEVISION, by John Southwell. Cloth. Pages xi+120. 13.5×20 cm. 1947. McGraw-Hill Book Company, 330 W. 42nd Street, New York 18, N. Y. Price $2.00.

Getting a Job in Television is an up-to-date, readable book giving pertinent, practical information to those young people interested in exploring the field of television as a possible vocation. Mr. Southwell writes in the clear, straightforward style of some of the popular digest magazines and addresses his readers in a chatty second person.

In a manner that would seem to appeal to secondary school students, the book

sketches the development of an embryonic industry, speculates intelligently on its potentialities, outlines the types of positions that will probably be needed in television, discusses the duties connected with these positions and their probable financial return, describes the temperament and personality needed in these jobs, and presents in a frank, realistic way the procedures and obstacles in obtaining these positions. Nowhere is an easy road to success depicted.

Much solid, authentic information is included in the book: a megacycle spectrum of present and proposed allocations of television frequencies by the Federal Communications Commission, a sample television script, list of established television stations and personnel, stations for which television licenses have been issued, list of station applications, list of New York advertising agencies having television departments, periodicals covering television news, New York casting and play agents, and leading New York producers and managers.

While the book is undoubtedly timely at this date, it remains for the future of television in the next few years to decide how long the book will remain apropos.

SHELDON S. MYERS

GEOMETRIA ANALITICA, by Hector T. Medici, *Professor at the National Military College of Argentina and* Emanuel S. Cabrera, *Professor at the Third School of Advanced Commercial Studies of Argentina* with a prologue by Professor Florencio D. Jaime. Paper cover. Pages 458. 14.5×20 cm. 1947. Libreria del Colegio. Alsina y Bolivar, Buenos Aires.

This recently published textbook of Plane Analytical Geometry must be considered as an important addition to the mathematical literature of the Spanish speaking world. The book written for students of college or university level more than covers the material that is expected of the university or technical institute students in this country both with respect to the breadth of the contents and depth of the analysis. The choice and arrangement of the material represents a very fortunate fusion of the best characteristics of the continental and Anglo-Saxon educational schools. In it we found the rigor and emphasis on analysis characteristic of the French books as well as the abundance of illustrative examples and stress on ability to solve problems characteristic of the American texts. The abundance of illustrative examples and carefully graded problems for solution, the clear and artistic figures as well as the graphical devices that abound in the book convince us that the guiding educational principle of the authors was that the book should be written, not only to help the student to understand a subject inherently difficult, but also to encourage him in further studies in the field of mathematics. In this textbook the authors do not try to impress and at the same time discourage the student with profound and elliptical language; on the contrary, they are understanding and patient. The authors obviously understand the contention that by presenting the subject the hard way the student—if forced to think—is nothing but medieval sophism untenable in modern times when emphasis is placed on the use of intellectual resources and energy of the student in discovering new truths and facts instead of rediscovering what has been known for centuries. With this we do not wish to minimize the value of the knowledge of the past, but simply to say that the acquisition of this knowledge must be obtained without inordinate effort on the part of the student. In fact, one of the few points that we find to criticize in this book is the fact that the authors neglected to implement the material with an historical sketch by means of which the student could appreciate how the problems of classical geometry that confronted Hippias, Menaechmus, Pappus and Appolonius find simple and elegant solutions by the methods of analytical geometry. In addition, we believe that the students should have some knowledge of the thoughts, methods of presentation and development of the subject by its pioneers.

To the beginner the various branches of mathematics are static and monolithic, somewhat the way the earth appears to be, for the man in the street, who is unaware of the dynamic changes the earth continuously undergoes. Thus, an historical sketch in which the contributions of Descartes, Fermat, Bernoulli, Parent,

Agnesi and others are presented would have served both in giving to the student the proper perspective to the magnitude of work done in the past and an insight into the changing methods of approach and formulation of mathematical concepts. In the *Geometria Analitica* the authors develop the material on the general lines used by mathematicians since the time of René Descartes and Pierre de Fermat; that is

a. Development of a mathematical method through which a geometrical problem can be transformed into a problem of algebra or, more generally, of mathematical analysis.
b. Solution of this problem by methods of analysis.
c. Geometrical interpretation of the results obtained.

The authors utilizing the above three steps proceed to give in a simple and methodical fashion all the theoretical material that serves to form a firm foundation for more advanced work. The text begins with an introductory chapter in the use of fundamental formulas of trigonometry and algebra with special emphasis on the application of determinants of which extensive use is made throughout the book and especially in connection with the study of conic sections. The subject matter is presented in eleven chapters of about equal length of which five are devoted to the topics of coordinates, straight line and transformation of coordinates, five to the study of conic sections and one to the study of higher plane curves. It is a pity that the authors did not include two or three chapters of solid analytical geometry, and thus in a single volume cover all the essential material for engineering students.

It is to be hoped that in a revised edition that the authors will be able to include these chapters together with an outline of selected topics for a shorter course and a page index. This review would be incomplete if we did not mention the excellent and illuminating prologue in which Professor F. D. Jaime touches upon some of the historical highlights pertaining to the role and the development of analytical geometry.

PHILIP A. CONSTANTINIDES
Chicago City College—Wilson Branch

THE POETRY OF MATHEMATICS AND OTHER ESSAYS, by David Eugene Smith, *Professor Emeritus of Mathematics, Teachers College, Columbia University*. Cloth, Pages v+90, 13×18 cm., 1947, Scripta Mathematical Library #1, *Scripta Mathematica*, 186th Street, New York, N. Y., Price, $1.25.

This interesting and valuable little book is the second printing of an edition which appeared in 1934, as the first of a series of monographs which introduced "The Scripta Mathematical Library." It was designed by *Scripta Mathematica* to bring to teachers and others non-mathematical articles which are related to lines of interest suggested by Mathematics.

There are five articles: (1) The Poetry of Mathematics, (2) The Call of Mathematics, (3) Religio Mathematici, (4) Thomas Jefferson and Mathematics, (5) Gaspard Monge, Politician.

Chapter one not only shows the rhythm and poetry of Mathematics but gives illustrations of Mathematics in Poetry. Poetry is the power subject of language as is Mathematics of Science.

Chapter two is an excellent answer to the question, Why study Mathematics and what is the meaning of failure.

To the reviewer chapter three is a masterpiece on what is faith, and the author has shown clearly how contacts in Mathematics will certainly lead to an increase in faith for any of those who have faith.

All historians will enjoy chapter four where Thomas Jefferson is presented in a non-political and intellectual light.

Chapter five gives an interesting side in the life of Monge, the inventor of Descriptive Geometry. As in chapter four where a politician's Mathematics life is portrayed, chapter five portrays the political side of a mathematician's life.

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